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Enlargement and Common External Tariff in a Political-Economic Model of Customs Union*

Subhayu Bandyopadhyay[a] Sajal Lahiri[b] and Suryadipta Roy[c]

Abstract

We present a model with three blocks of nations: two of the blocks are members of a Customs Union (CU) and maintain a common external tariff (CET) on the third (non-member). One of the member blocks is a block of new entrants. The producing lobby is assumed to be union-wide and lobbies governments of both blocks to influence the CET. The CET is determined jointly by the CU. We follow the political support function approach, where the CU seeks to maximize a weighted sum of the constituents' payoff functions. In this framework, we find the relationship between the CET and the average level of capital stock owned by the protected sector in the block of new entrants. We find that the CET is unambiguously larger if the new entrants have a larger stock of capital.

JEL Classification : F13

Keywords : Enlargement, Customs union, Common external tariff, Politics.

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1. Introduction

The European Union (EU) has been one of the most successful and dynamic case of Customs Union (CU) that have been tried. The EU has changed very significantly over the years both in terms of its scope and membership. It started merely as an economic community after the Treaty of Rome in 1957 with six founding members: Belgium, France, Germany, Italy, Luxembourg and the Netherlands. In terms of membership, it has undergone four successive enlargements with Denmark, Ireland and the United Kingdom joining in 1973, Greece in 1981, Portugal and Spain in 1986, and Austria, Finland and Sweden in 1995. The year 2004 saw the biggest enlargement with ten other countries (Czech Republic, Cyprus, Estonia, Latvia, Lithuania, Hungary, Malta, Poland, Slovenia and Slovakia) joining the EU. Two years later two more countries (Bulgaria and Romania) joined the EU, making it a 27-nation Customs Union (CU). Currently, negotiations are going on with many other countries, such as Turkey, for possible accession in the near future.

There has been a proliferation of preferential trading agreements in all parts of the world. Prominent among them are the NAFTA and the EU. In the former arrangement, member nations have free trade between them, but set their tariffs on

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non-members independently. This is an example of a Free Trade Area (FTA). On the other hand, EU is organized along the lines of a CU, where, in addition to intra-bloc free trade, the members set a common tariff on non-members (i.e., the common external tariff - CET). The CET is determined jointly by the member nations, with different members having different levels of influence on the decision making. Efforts exercised by different members in the decision making are also typically influenced by lobbying from interest groups.

This paper examines the effect of the nature of an enlargement of a CU on the CET. We do so by developing a political-economy model for the determination of the CET in which lobbying by the sector of production protected by the CET plays an important role.

There is a large and growing literature on the effect of lobbying on various variables. There are broadly two strands of this literature. One is along the lines of DUP (Directly Unproductive Profit-Seeking Activities) a la Bhagwati (1982). Panagariya and Rodrik (1993), Panagariya and Findlay (1996), among others, follow this approach. The second strand follows the pioneering work of Grossman and Helpman (1994), where contributions by lobbyists and its influence on trade policy is considered explicitly.[1]

A substantial part of the literature on the political economy of trade policy is concerned with preferential trading agreements (PTAs). Krishna (1998) finds that trade diverting preferential agreements are more likely to be supported by firms within a union, because the gain is at the expense of the market share of firms based in non-member nations. Thus, political economy factors favor trade diverting unions compared to trade creating ones and this is undesirable from the perspective of multilateral trade liberalization. Cadot, de Melo and Olarreaga (1999) present a political economy model following the Grossman and Helpman (1994) approach. They find that "deep integration" within PTAs leads to rising protection levels against non-member nations.[2] Tavares (2006) provides an empirical analysis of CET determination in the EU. She finds evidence of logrolling in voting for the CET and her results suggest that the members used the unanimity principle.

Saggi (2006) presents an oligopoly model to focus on the role of symmetry (and asymmetry) between three trading nations. Assuming symmetry, he finds that the cooperative agreement is more difficult to sustain compared to Most Favored Nation (MFN) for both an FTA and a CU. Under cost (and market size) asymmetry between the nations, he finds that asymmetry may, under certain situations, improve rather than hurt cooperation. Riezman (1979) shows that if intra-union trade vol-

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1. Mitra (1999) builds on this framework and considers how lobbies may be formed endogenously. Along these lines, Krishna and Mitra (2005) argue that it may be a good idea to unilaterally reduce tariffs in certain situations, because this may strengthen the export lobby in the foreign nation to form and lobby that nation's government towards a more liberal trade policy.
2. For example, the definition of "deep integration" in CU that they provide (page-646) is: "..under deep integration, the CU's trade policy is determined by a pan-union agency (such as the European Commission) subject to influence by pan-union lobbies (such as EROFER, the European Union's steel lobby, and others)."

ume is small, all members of a CU are likely to benefit from it. With a smaller intra-union volume, a potential terms of trade loss of one member with respect to another is likely to be dominated by terms of trade gains from external trade. Kennan and Riezman (1990) highlight the rise in the CET due to coordination between members which allows them to internalize terms of trade externalities created by their respective tariff policies. Bond *et al.* (2004) find that if FTA member nations are sufficiently large they benefit from such an agreement because of larger intra-union trade liberalization effects which dominate the adverse terms of trade effects vis-à-vis the rest of the world. Raimondos-Moller and Woodland (2006) show that even non-preferential trading clubs can gain from coordinated tariff reforms in the presence of income transfers between member nations. A computational approach pursued by Abrego *at al.* (2006) finds that a CU tends to raise external tariffs in a large majority of cases. This paper is distinct in that the focus is not on traditional efficiency or terms of trade motives of tariff changes but rather on the political determinants of the CET. Unlike some of these papers which deal with asymmetry, the focus here is not on differences in endowments or volume of trade but rather on parameters reflecting underlying political conditions of member nations.

The above literature abstracts from cross-border lobbying by firms. A recent contribution by Gawande, Krishna and Robbins (2006) finds that foreign lobbies play an empirically significant role in the determination of US tariffs. Allowing for cross-border lobbying, Grossman and Helpman (1995, Appendix) find that FTAs may be more difficult to implement. This is because a lobby can block the agreement not only by lobbying its own government but it may approach the other member government as well. Schiff and Winters (2003, page-92) worry that regional integration may accentuate cooperation of lobbying groups and raise protection.[3] In a similar vein, Bandyopadhyay and Wall (1999) present a model of cross-border lobbying and compare FTA and CU tariffs. In an FTA, tariff of a nation is determined through a tariff generating function a la Findlay and Wellisz (1982). Each member nation's firm (that is competing with the non-members imports) simply lobbies their nation's government and there is no incentive to engage in cross-border lobbying. The endogenous FTA tariff of a nation depends on the tariff generating function of that nation and its marginal cost of lobbying. In contrast, the CU determines a CET that is generated through a lobbying function which is a convex combination of the respective nations' tariff generating functions. Lobbying is aimed by the union-wide industry at both member governments. They find that the CET is higher than the FTA tariff unless the two member nations are symmetric. Recently Bandyopadhyay *et al.* (2009) generalized and extended the model of Bandyopadhyay and Wall (1999) by endogenizing the tariff-formation function in a very general framework, and examined the role of political asymmetries in the determination of the CET. The present paper adopts the endogenous tariff formation *a la* Bandyopadhyay *et al.* (2009) to a very specific model of CU and examines the effect of an enlargement of the CU on the CET.

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[3] Winters (1993) raises similar concerns about the political economy of tariff setting in the European union.

The findings of this paper have important policy implications. In constituting a CU, one should not ignore potential members who are capital-poor in the import competing sector (i.e. have lower endowment of specific capital), because they tend to minimize the protection-enhancing effect on non-members.[4] Alternately, when one is considering expansion of a CU, the more capital-poor the new members are, the less harmful it will be (from a multilateral perspective) to expand the union.

2. The Model and Analysis

In our model there are three countries labeled *A*, *B* and *C* and four goods - 1, 2, 3 and 4. For the purpose of this paper, it will be helpful to interpret *A* as the representative of the block of existing members, *B* the representative of the block of new entrants, and *C* the rest of the world.

A and *B* both export good 4 to *C*. Also, goods 1, 2 and 3 are export goods of *A*, *B* and *C*, respectively[5]. *A* and *B* are members of a Customs Union (CU). *C* represents the rest of the world. *A* and *B* are small in relation to country *C*, so that the prices of all the goods are determined in *C*. The Common external tariff (CET) of the CU is determined in a three stage game in *A* and *B*. In the first stage, the import competing industry engages in lobbying for the CET. In the second stage, the CU chooses the CET. In the third and final stage, individual competitive firms choose their output levels. In order to achieve a sub-game-perfect equilibrium, we work with a backward induction.

A imports goods 2 and 3 from *B* and *C*, respectively. Since *B* is a member of the CU, there cannot be any tariff in *A* on good-2. Thus, lobbying is done only for a tariff on good-3. The same logic applies to *B*. Let us assume that both *A* and *B* have the same linear production function for good-4:

$$X_4 = w_0 L_4;\ 0 < w_0 < 1, \tag{1}$$

where L_4 is labor used in producing good-4. The wage rate in both nations (*A* and *B*) must be:

$$w = p_4 w_0, \tag{2}$$

where p_4 is the price of good-4. By suitable choice of units we can set p_4 to unity.

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[4] See for example, Winters (1993), Grossman and Helpman (1995) and Schiff and Winters (2003) for a discussion on protection-augmenting effects in a CU.

[5] *C* is not explicitly modeled in this paper. We lay out the preference and production structures in *A* and *B* below. The asymmetry between *A* and *B* that drives their respective patterns of trade is through the asymmetry in their respective endowments of specific capital for goods 1 and 2. *A* (*B*) has a sufficiently large endowment of capital specific to good-1 (good-2) to make it a net exporter of the good.

2.1. *National Welfare of a Member Nation*

We assume that there is a representative consumer in nation-j (j=A,B) with the following utility function:

$$U^j = u(c_1^j, c_2^j, c_3^j) + c_4^j \tag{3}$$

where c^j_i is the consumption of good-*i* in nation *j*. Let m^j be the income of the consumer in nation *j*. Assuming identical utility functions between *A* and *B* and noting that the consumers in *A* and *B* face a common set of prices (in a CU), the indirect utility function is:

$$V^j = v^j(p_1, p_2, p_3) + m^j,\ \mathrm{j} = A,\ B, \tag{4}$$

where, $v^j(p_1,p_2,p_3) = u\{c_1^j(.), c_2^j(.), c_3^j(.)\} - \sum_{i=1}^{3} p_i c_i^j(.)$, and $c_i^j(.) = c_i^j(p_1, p_2, p_3)$.

Without loss of any generality, we set all international prices to unity. The domestic prices of good-1 and good-2 are one, but the domestic price of good-3 is 1 + *t*, where *t* is the CET on good-3. Denoting by X_i^j the output of good-*i* in nation-j, we have:

$$m^j = X_1^j + X_2^j + (1+t)X_3^j + X_4^j + t(C_3^j - X_3^j) \tag{5}$$

We assume that goods 1-3 are produced using identical Leontief technology in the two nations:

$$X_i = Min\{a_i K_i, L_i\};\ i = 1,2,3 \tag{6}$$

where a is the labor to capital ratio in good-*i*. Also, denote by $\bar{K}_i^j$ the good-*i* -specific capital stock in nation-*j*. Then:

$$X_i^j = a_i \bar{K}_i^j,\ \text{where},\ i = 1,2,3\ ;\ \mathrm{j} = A,\ B. \tag{7}$$

Using (6) and (7), we have

$$L_i^j = a_i \bar{K}_i^j \tag{8}$$

Using (1) and (7), and noting that the level of consumption of good-3 is identical in A and B, (5) reduces to:

$$\begin{aligned} m^j &= a_1\bar{K}_1^j + a_2\bar{K}_2^j + a_3\bar{K}_3^j + X_4^j + tC_3(p_3 = 1+t) \\ &= a_1\bar{K}_1^j + a_2\bar{K}_2^j + a_3\bar{K}_3^j + w_0 L_4^j + tC_3(p_3 = 1+t) \end{aligned} \tag{9}$$

Denoting by $\bar{L}^j$ the endowment of labor in country *j*, by L_i^j amount of labor used in the production of good-*i* in country *j*, and by h_i the union-wide lobbying group's use of lobbying resources from nation j,[6] we have

$$L_4^j = \bar{L}^j - h_j - L_1^j - L_2^j - L_3^j \tag{10}$$

Using (8) and (10) in (9):

$$m^j = \bar{B}^j + w_0(\bar{L}^j - h_j) + tC_3(1+t) \tag{11}$$

where $\bar{B}^j = a_1\bar{K}_1^j + a_2\bar{K}_2^j + a_3\bar{K}_3^j - w_0(\sum_{i=1}^{3} a_i\bar{K}_i^j)$.

Note that $\bar{B}^j$ is independent of t. Using (11) in (4), the indirect utility function of the representative individual in nation-j is derived as:

$$V^j = v^j(1,1,1+t) + \bar{B}^j + w_0(\bar{L}^j - h_j) + tC_3(1+t) \tag{12a}$$

(12a) can be written as:

$$V^j = S^j(t) - w_0 h_j, \tag{12b}$$

where, $S^j(t) = v^j(1,1,1+t) + \bar{B}^j + w_0\bar{L}^j + tC_3(1+t)$.

2.2 *Government Objective Function*

Under the CET, the price of good-3 is equalized across the union (of A and B) and the benefit from a higher CET accrues to the union-wide industry for good-3. We assume that lobbying is organized at this union level and the industry lobbies the member governments for a higher tariff. Each member nation's government can be influenced by this lobbying to attach an extra weight to the industry's producer surplus net of lobbying contributions.[7] This weight is assumed to be increasing in lobbying effort with diminishing returns. That is, denoting by P^j the weight attached by nation-j to the producer surplus of good-3, we have:

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[6] Here we follow the DUP (Directly Unproductive Profit-Seeking Activities, *a la* Bhagwati; see chapter 34 of Bhagwati et al., 1998, for a nice survey) approach. In the DUP approach, lobbying is analyzed as an activity that requires real resources which are taken away from productive activities and used for rent seeking. Therefore, lobbying causes a direct income loss for the nation and also indirectly affects national income through its effects on import tariffs (and hence relative prices).

[7] A strand of the existing literature (e.g., Panagariya-Rodrik, 1993) assumes that lobbying increases tariffs. The rationale is that through lobbying a government is influenced to attach special importance to the lobbying group. We propose a channel through which the lobbying may influence the government. It can be viewed as an advertising campaign conducted by the union wide industry to convince a member government to attach a higher weight to that industry. In turn, this weight will increase, the greater the resources spent by the industry in this campaign.

$$\rho^j = \rho^j(h^j),\ \frac{d\rho^j}{dh^j} > 0, \text{ and } \frac{d^2\rho^j}{dh^{j^2}} < 0,\ j = A, B; \tag{13}$$

where h^j is the lobbying effort expended on nation-j's government by the union-wide lobby. The objective function of nation-j's government is:

$$G^j = S^j(t) - w_0 h_j + \rho^j(h^j)[\pi^{3A}(1+t) + \pi^{3B}(1+t) - w_0(h^A + h^B)], \tag{14}$$

where, as mentioned earlier, h_j is the amount of lobbying resources of nation-j used by the union-wide lobby. $\pi^{3j}(1+t)$ is the surplus for producers (of good-3) located in nation-j. Using (7) above, the producer surplus of sector-3 in country j is:

$$\pi^{3j}(1+t) = (1+t)X_3^j - w_0 L_3^j \Rightarrow \pi^{3j}(1+t) = (1+t-w_0)a_3\bar{K}_3^j. \tag{15}$$

Using (15) in (14), we get

$$G^j(t, h_j, h^j, h^i) = S^j(t) - w_0 h_j + \rho^j(h^j)[(1+t-w_0)\tilde{K} - w_0(h^j + h^i)].$$

$$j, i = A, B;\ j \neq i, \text{ and, } \tilde{K} = a_3(\bar{K}_3^A + \bar{K}_3^B). \tag{16}$$

2.3. *Tariff Determination by the Customs Union (Stage-2)*

Following the political support function approach, we assume that the CU tariff-setting body maximizes a weighted sum of the member-nation governments' objective functions.[8] The weights may differ to capture asymmetric national influence on the tariff setting process. Let α be the relative weight attached to A. Then the CU objective function is:

$$C(t, h_A, h_B, h^A, h^B) = \alpha G^A(t, h_A, h^A, h^B) + (1-\alpha)G^B(t, h_B, h^B, h^A) \tag{17}$$

Noting that lobbying is done in stage-1, the first order condition for the choice of t is:

$$\alpha\frac{\partial G^A}{\partial t} + (1-\alpha)\frac{\partial G^B}{\partial t} = 0 \tag{18}$$

From (16), it can be derived that:

$$\frac{\partial G^A}{\partial t} = \frac{\partial S^A}{\partial t} + \rho^A(h^A)\tilde{K}, \text{ and, } \frac{\partial G^B}{\partial t} = \frac{\partial S^B}{\partial t} + \rho^B(h^B)\tilde{K}. \tag{19a}$$

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[8] See Hillman (1982) and Rodrik (1995, pages 1464-65) for simple expositions.

Using (11) and (12b), noting the equalization of consumer prices over the union, and given that the utility functions are identical between A and B, we have:

$$\frac{\partial S^A}{\partial t} = \frac{\partial S^B}{\partial t} = S'(t) \qquad (19b)$$

Using (18), (19a) and (19b):

$$S'(t) + \tilde{K}\mu = 0 \Rightarrow t = t(\tilde{K}\mu), \text{ where, } \mu = \alpha\rho^A(h^A) + (1-\alpha)\rho^B(h^B) \qquad (20a)$$

Using (20a), we find:

$$\frac{dt}{d\mu} = \frac{\tilde{K}}{-S''(t)} > 0, \qquad (20b)$$

since $S''(t) < 0$ in order to satisfy the second order condition of the choice of the CU tariff. From (20a) and (20b) notice that given $\tilde{K}$, the CET depends entirely on μ, which may be thought of as a composite weight attached by the tariff setting authority to union-wide producer interests (in good-3). Of course, μ is endogenous and depends on the equilibrium levels of h^A and h^B, described in the following sub-section. For tractability, let us assume a specific form for the ρ^J functions:

$$\rho^j(h^j) = \delta_j (h^j)^\eta, \text{ where, } j = A, B, \text{ and, } 0 < \eta < 1 \qquad (21)$$

Formulation (21) assumes that lobbying directed at a member government will raise the weight attached by the nation to the lobbying sector's (i.e., sector-3) producer surplus. Diminishing returns imply that this effect becomes smaller as lobbying increases. Assuming that the nations are equally susceptible to lobbying, a normalization that we can use is: $\delta_A = \delta_B = 1$. Using (21) in (20a), we get

$$\mu(h^A, h^B) = \alpha(h^A)^\eta + (1-\alpha)(h^B)^\eta \qquad (22a)$$

$$d\mu = \mu_1 dh^A + \mu_2 dh^B \qquad (22b)$$

where μ_1 and μ_2 are strictly positive.

2.4. *The Determination of Lobbying Activities (Stage-1)*

The union-wide industry maximizes the joint profits net of lobbying costs:

$$\pi^{CU} = \pi^{3A}(1+t) + \pi^{3B}(1+t) - w_0(h^A + h^B) = (1 + t - w_0)\tilde{K} - w_0(h^A + h^B). \qquad (23a)$$

Using (20a) through (22a) in (23a):

$$\pi^{CU} = [1 + t\{\mu(h^A, h^B)\} - w_0]\tilde{K} - w_0(h^A + h^B) \qquad (23b)$$

The industry's first order conditions on how much to lobby the respective governments is given by:

$$\tilde{K}t'(\mu)\left(\frac{\partial\mu}{\partial h^j}\right)=w_0;\ j=A,B. \tag{24a}$$

(24a) implies:

$$\frac{\partial\mu}{\partial h^A}=\frac{\partial\mu}{\partial h^B}. \tag{24b}$$

(24b) requires that at the optimum the marginal returns to the industry from lobbying the two governments must be equalized. Using (22a) and (24b) :

$$\frac{h^A}{h^B}=\left(\frac{\alpha}{1-\alpha}\right)^{\frac{1}{1-\eta}}. \tag{25}$$

From (25) it is clear that a rise in A's influence (i.e., α) will raise the relative amount of lobbying directed at A. Using (22a) and (24a) we can solve for the equilibrium lobbying levels:

$$h^A=\left[\frac{\tilde{K}\alpha\eta t'(\mu)}{w_0}\right]^{\frac{1}{1-\eta}};\text{ and, } h^B=\left[\frac{\tilde{K}(1-\alpha)\eta t'(\mu)}{w_0}\right]^{\frac{1}{1-\eta}}. \tag{26}$$

This completes the description of our political equilibrium. We shall examine the effect of the nature of CU enlargement on the equilibrium level of CET.

2.5. *CU Enlargement and the CET*

In this subsection we shall analyze the consequence of accepting richer countries than poorer ones. We shall do so by considering two possibilities with respect to the block of countries *B*, and these possibilities related to the level of capital stock (i.e., $\bar{K}_3^B$) that the protected sectors of the new entrants own. Using (26) in (22a) and differentiating it we get:

$$D^{\mu}d\mu=D^{K}d\tilde{K} \tag{27}$$

where,

$$D^{\mu}=1-\frac{\alpha^2\eta^2(\tilde{K})^2}{(1-\eta)w_0}\left\{\frac{\tilde{K}\alpha t'}{w_0}\right\}^{\frac{2\eta-1}{1-\eta}}t''-\frac{(1-\alpha)^2\eta^2(\tilde{K})^2}{(1-\eta)w_0}\left\{\frac{\tilde{K}(1-\alpha)\eta t'}{w_0}\right\}^{\frac{2\eta-1}{1-\eta}}t'',$$

and,

$$D^{K}=\left[\frac{\alpha^2\eta^2}{(1-\eta)}\left\{\frac{\tilde{K}\alpha\eta t'}{w_0}\right\}^{\frac{2\eta-1}{1-\eta}}+\frac{(1-\alpha)^2\eta^2}{(1-\eta)w_0}\left\{\frac{\tilde{K}(1-\alpha)\eta t'}{w_0}\right\}^{\frac{2\eta-1}{1-\eta}}\right](t'+\tilde{K}\mu t'').$$

Now, from (20a) we get:

$$\frac{dt}{d\tilde{K}} = t'\left(\mu + \tilde{K}\frac{d\mu}{d\tilde{K}}\right). \tag{28}$$

Using (27) we obtain:

$$\mu + \tilde{K}\frac{d\mu}{d\tilde{K}} = \frac{\mu + \left\{t'D^k / \left(t' + t''\tilde{K}\mu\right)\right\}}{D^\mu}. \tag{29}$$

From the second order condition for the stage 1 optimization problem, we have $D^\mu > 0$, and from (27), $D^K / (t' + t''\tilde{K}\mu) > 0$. Therefore:

$$\frac{dt}{d\tilde{K}} > 0. \tag{30}$$

Enlargement of the CU will mean an increase in $\tilde{K}$, which reflects the aggregate capital stock of the union. This should raise the CET. In turn, since the relationship is monotonic, we can infer that the larger the capital stock of the entrant, the larger will be the rise in the CET. If the entrant is capital-rich, at least in the sense that it has a larger capital stock in the protected sector, we can expect the CET enhancing effect of the enlargement to be stronger. This result has the interesting policy implication that if we want to reduce the anti-trade bias of CU expansion, we should focus on entrants that are relatively capital-poor. The intuition is the following. The marginal benefit from lobbying is proportional to the output of the industry. In turn, this is positively related to the aggregate capital stock. Capital-rich entrants lead to larger increases in the marginal benefit from lobbying, raising union-wide lobbying and the CET.

3. Conclusion

In a CU, the union-wide industry chooses how much to lobby the individual governments of a CU. In the presence of cross-border lobbying, the productivity of such lobbying depends, inter alia, on the size of initial profits of the lobbying groups.

If the new entrants have a bigger protected group, then the productivity of lobbying is larger and therefore more lobbying takes place, making the CET bigger. To be more specific, we have found that there is a positive monotonic relationship between the level of capital stock owned by the protected sectors (of the new entrants) and the level of the CET. These results have interesting policy implications for CU enlargement. Capital-rich new entrants are likely to encourage more protectionist policies with respect to non-members. In turn, this implies that when considering CU expansion, free trade oriented members should be less sympathetic to bringing in capital-rich fresh entrants.

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Licensing by an outside innovation in an unionized labor market : the case of a positive opportunity cost

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Abstract

In an economy with unionized labor market, we determine an outside innovator's preferred mode of licensing when the opportunity costs of the licensees are positive. We show that auction is dominated by fixed-fee licensing, which is dominated by royalty licensing. A licensing scheme with both fixed-fee and royalty is preferable to the innovator than a royalty only licensing.

Key Words : Auction ; Fixed-fee licensing ; Labor union ; Royalty licensing
JEL Classification : D43; L13; J51

1. Introduction

Technology licensing is an important element of conduct in many industries and has attracted fair amount of attention in recent years. The seminal works by Kamien and Tauman (1984 and 1986) show that, if an innovator, who is not a producer[1], licenses its technology to the final goods producers and the product market is characterized by Cournot competition, licensing by means of an output royalty generates lower profit to the innovator compared to fixed-fee licensing and auction, regardless of the industry size and/or magnitude of the innovation.[2] In view of this theoretical result, the wide prevalence of output royalty in the licensing contracts (see, e.g., Taylor and Silberstone, 1973 and Rostoker, 19984) remains a puzzle, and has generated significant amount of theoretical research to explain the superiority of royalty-licensing over other types of licensing contracts. The factors attributed to the presence of output royalty in a licensing contract offered by an "outside innovator"[3] are asymmetric information (Gallini and Wright, 1990, Beggs, 1992, Poddar and Sinha, 2002 and Sen, 2005b), product differentiation (Muto, 1993 and Poddar and Sinha, 2004), moral hazard (Macho-Stadler et al., 1996 and Choi, 2001), risk aversion (Bousquet et al., 1998), incumbent innovator (Shapiro, 1985, Kamien and Tauman, 2002 and Sen and Tauman, 2007), leadership structure (Kabiraj, 2004), strategic delegation (Saracho, 2002) and the integer constraint on the number of licenses (Sen, 2005a).[4]

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[1] Licensing by the Universities or independent research labs to the producers may be the examples of this scenario.

[2] See Kamien (1992) for a nice survey of this literature.

[3] Outside innovator refers to the situation were the innovator (who is the licenser) and the licensees do not compete in the product market.

[4] There is a related literature which shows the superiority of royalty licensing and licensing with a combination of fixed-fee and royalty when the licenser and the licensees compete in the product market (see, e.g., Rockett, 1990, Wang, 1998 and 2002, Wang and Yang, 1999, Filippini, 2001, Mukherjee and Balasubramanian, 2001, Faulk-Oller and Sandonis, 2002, Sen, 2002, Fosfuri, 2004, Kabiraj, 2005, Poddar and Sinha, 2005 and Mukherjee, 2007).

In a recent paper, Mukherjee (2009) shows that royalty licensing can dominate fixed-fee licensing and auction in the presence of labor union, if bargaining power of the labor union is high, thus showing the implications of input market. However, the formal analysis of Mukherjee (2009) considers that the opportunty costs of the licensees are zero, which is a reasonable assumption for many situations. For example, this situation may correspond to the case of drastic innovation in the sense of Arrow (1962). Alternatively, one may assume that the licenses are not producing any product which is in competition with the innovated product. For example, a developed-country producer may have invented a new product and can enter a developing country only through technology licensing (due to higher costs of exporting and foreign direct investment) to the producers in a developing country.

However, there may be several other situations where the opportunity costs of the licensees are positive. We do a formal analysis in this paper to determine an outside innovator's preferred mode of licensing when the opportunity costs of the licensees are positive.[5] We use a simple model to show that the profit of the innovator under auction can be lower than its profit under fixed-fee licensing, and its profit can be lower under fixed-fee licensing than under royalty licensing. Hence, in the presence of input market imperfection, an outside innovator may prefer royalty licensing than fixed-fee licensing or auction even if the opportunity costs of the licensees are positive. It follows from our analysis that a combination of royalty and fixed-fee is better for the innovator than a royalty only licensing.

The remainder of the paper is organized as follows. Section 2 describes the model and shows the results. Section 3 concludes.

2. The model and the results

Assume that there are n firms producing product x with their own technologies. To avoid analytical complexity, we ignore integer constraint and consider the number of producers (i.e., n) as a continuous variable. Assume that each firm requires one labor to produce one unit of x and the inverse market demand function for product x is $P_x = a - x$.

The wage rates for the workers are determined by the firm-specific labor unions and the firms hire workers according to their need. Hence, we consider a right-to-manage model of labor union, such as in Bughin and Vannini (1995), Vannini and Bughin (2000), López and Naylor (2004) and Mukherjee (2008), to name a few, where the producers and the unions bargain for the wage rates and the producers demand workers according to their need.[6] To show our results in the simplest way, we consider that the labor union has full bargaining power, thus providing the maximum effect of unionization. We assume that the reservation wage rates of the workers are zero.

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[5] Even if Mukherjee (2009) discusses possible implications of positive opprtunity costs of the licensees, it leaves the formal analysis for future research. Here we do the formal analysis for the positive opportunity costs of the licensees under firm-specific unions.

[6] The "efficient bargaining" model, which stipulates that the firms and unions bargain over wages and employment, is an alternative to the right-to-manage model. See, Layard et al. (1991) for arguments in favor of right-to-manage models.

Given the firm-specific wage rates, w_i, $i = 1, 2, \ldots, n$, each firm producing x maximizes the following expression to determine its output:

$$\underset{x_i}{Max}(a - x - w_i)x_i \tag{1}$$

The equilibrium output of each firm producing x can be found as $x_i = \dfrac{a - nw_i + \sum\limits_{\substack{j=1 \\ i\neq j}}^{n} w_j}{n+1}$, $i = 1, 2, \ldots, n$, which is the labor demand faced by the corresponding labor union.

The *i*th firm maximizes the following expression to determine w_i:

$$\underset{w_i}{Max}\frac{w_i(a - nw_i + \sum\limits_{\substack{j=1 \\ i\neq j}}^{n} w_j)}{(n+1)} \tag{2}$$

The equilibrium wage rate can be found as $w_i = \dfrac{a}{n+1}$, $i = 1, 2, \ldots, n$, and the profit of each producer is $\pi_i = \dfrac{a^2 n^2}{(n+1)^4}$.

Now assume that there is a new product, called product *y*, which has been invented by an innovator *I*, which cannot produce the good. However, *I* can license its technology of product y to the producers of *x*.

Assume that the inverse market demand function for y is $P_y = b - y$, where $b > a$. Note that we have assumed away competition between x and y. Hence, we may think that these products target different types of consumers.[7] This assumption helps us to reduce the analytical complexity significantly, yet it captures the main implications of positive opportunity costs which are affected by the number of firms producing x and y. Following Kamien et al. (1988), we assume that the each producer can produce either x or y. This may be due to the diseconomies related to production of more products. Our assumption of $b > a$ is then necessary to induce the producers to switch from product x to product y. Finally, we assume that each firm requires one labor to produce one unit of y.

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[7] As a hypothetical situation one may assume that product x is a medicine for cold, while product y is a medicine for cancer. Hence, the firm producing x is not in competition with the firms producing.

We consider the following licensing contracts designed by I :

(i) Royalty licensing, where a fixed royalty payment r per unit of output is charged by I, and any producer that wishes to can purchase the license at this royalty rate.

(ii) Fixed-fee licensing, where a flat pre-determined license fee F is charged by I, and any producer that wishes to can purchase the license at this fixed-fee.

(iii) Auctioning k licenses, $1 \leq k \leq n$, by I through a sealed bid English auction. The highest bidders get license. The ties are resolved by I[8].

It is immediate from Kamien et al. (1992) that the essential difference between auction and fixed-fee licensing stems from the difference in producers' opportunity costs of getting a license. When there are k licenses, the opportunity cost of each producer under auction is his gross profit from being a non-licensee when k producers purchase license, while the opportunity cost of each producer under fixed-fee licensing is his gross profit from being a non-licensee when (k–1) producers purchase license.

We consider the following games for our analysis. Under royalty licensing, at stage 1, I announces the uniform royalty rate r. At stage 2, the producers simultaneously and independently decide whether or not to purchase a license. At stage 3, the wage rates are determined simultaneously. At stage 4, the producers choose their outputs simultaneously. If only one producer purchases a license at stage 2, he produces like a monopolist at stage 4.

In the case of fixed-fee licensing, at stage 1, I announces the uniform fixed-fee F. At stage 2, the producers simultaneously and independently decide whether or not to purchase a license. At stage 3, the wage rates are determined simultaneously. At stage 4, the producers choose their outputs simultaneously. If only one producer purchases a license at stage 2, he produces like a monopolist at stage 4.

In the case of auction, at stage 1, I announces to auction k licenses, where $1 \leq k \leq n$. At stage 2, the producers simultaneously and independently decide whether or not to purchase a license, and how much to bid. At stage 3, the wage rates are determined simultaneously. At stage 4, the producers choose their outputs simultaneously. If I auctions only one license, the licensee produces like a monopolist at stage 4. We solve these games by backward induction.

Consider the case where I licenses y through a per-unit output royalty r. If k producers purchase the license, given the wage rate w, the sth licensee maximizes the following expression to determine its output:

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[8] As pointed out in Kamien et al. (1992), if the innovator auctions y licenses, each producer is assured a license, and bids as little as possible. Hence, to induce the producers to bid their maximum willingness to pay, the innovator needs to specify a minimum bid for n = k.

$$\underset{y_s}{Max}(a-y-w_s-r)y_s, \qquad (3)$$

where $s = 1, 2, ..., k$. The equilibrium output of the s th licensee can be found as $y_s = \frac{b-kw_s-r+\sum_{\substack{m=1 \\ s\neq m}}^{k} w_m}{k+1}$. Without loss of generality, we assume that first k producers take the license, and the remaining $(n-k)$ producers produce product x.

The t th producer producing x maximizes the following expression to determine its output:

$$\underset{x_t}{Max}(a-x-w_t)x_t \qquad (4)$$

where $(t = k+1, k+2, ..., n$. The equilibrium output of the t th producer producing x can be found as $x_t = \frac{a-(n-k)w_t+\sum_{\substack{z=k+1 \\ t\neq z}}^{n} w_z}{n-k+1}$, $t = k+1, k+2, ..., n$.

The equilibrium wage for each producer of y is $w_y = \frac{b-r}{k+1}$, and the equilibrium wage for each producer of x is $w_x = \frac{a}{n-k+1}$[9]. The equilibrium output of each producer of y is $y_s(k) = \frac{k(b-r)}{(k+1)^2}$, and the equilibrium output of each producer of x is $x_t(k) = \frac{a(n-k)}{(n-k+1)^2}$[10].

The innovator chooses the royalty rate to maximize his profit $\pi^{I,r} = \frac{k^2 r(b-r)}{(k+1)^2}$. The royalty rate that maximizes the profit of the innovator is

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9. Since these equilibrium values follow from standard calculations, we skip the details here.

10. The arguments in y and x show the number of licensees. If there are k licensees, it implies that $(n-k)$ firms produce x. As k reduces, say to $(k-1)$, it increases the number of firms producing x to $(n-k+1)$.

$r^* = \frac{b}{2}$. The profit of each producer of y is $\pi^y(k) = \frac{k^2b^2}{4(k+1)^4}$. The profit of each producer of x is $\pi^x(k) = \frac{(n-k)^2a^2}{(n-k+1)^4}$. Hence, each of the k producers finds it profitable to switch to product y from product x if $\pi^y(k) > \pi^x(k-1)$ or $b > \frac{2a(n-k+1)(k+1)^2}{k(n-k+2)^2} \equiv \bar{b}$. Given other things, the consumers' maximum willingness to pay for y, i.e., b, needs to be sufficiently higher than the consumers' maximum willingness to pay for x, i.e., a. As k increases, it increases $\bar{b}$. On one hand, ceteris paribus, a higher k reduces $\pi^y(k)$, but, on the other hand, it increases the profit of each remaining producer of x. Therefore, ceteris paribus, if k increases, b needs to be higher to induce more producers to produce y. We get that all the producers of x have the incentive to switch to y, i.e., $k = n$. if $b > \frac{a(n+1)^2}{2n}$. If this condition holds, the profit of the innovator is

$$\pi_r^I = \frac{n^2b^2}{4(n+1)^2} \tag{5}$$

If $b < \frac{a(n+1)^2}{2n}$, the innovator needs to reduce the royalty rate from $\frac{b}{2}$ to induce n producers to purchase a license of y, since for a given k, the marginal cost of production for y, which is $w_y + r = \frac{b+kr}{k+1}$, reduces with r. For a given k, a lower r increases $w_y = \frac{b-r}{k+1}$, but it reduces $w_y + r$. Therefore, if $b < \frac{a(n+1)^2}{2n}$, the innovator needs to charge a constrained royalty rate to induce n producers to purchase the license. In this situation, the innovator faces the trade-off between selling more licenses at a lower royalty rate and selling fewer licenses at a higher royalty rate. However, in the following analysis, we will assume that $b > \frac{a(n+1)^2}{2n}$. This will help to serve our purpose in the simplest way without sacrificing the main insight.

Now consider the case of a fixed-fee licensing. If k producers take the license, each licensee produces $y_s(k) = \frac{kb}{(k+1)^2}$, and each non-licensee produces

$x_i(k) = \frac{a(n-k)}{(n-k+1)^2}$.[11] The profit of each licensee is $\pi^y(k) = \frac{k^2b^2}{(k+1)^4}$, and the profit of each non-licensee is $\pi^x(k) = \frac{(n-k)^2a^2}{(n-k+1)^4}$.

If there are k licenses under fixed-fee licensing, each licensee's opportunity cost of getting the license is $\pi^x(k-1) = \frac{(n-k+1)^2a^2}{(n-k+2)^4}$. Hence, the maximum fee each producer wants to pay to be one of the k licensees is the net gain from licensing, which is $F(k) = \pi^y(k) - \pi^x(k-1) = \frac{k^2b^2}{(k+1)^4} - \frac{(n-k+1)^2a^2}{(n-k+2)^4}$. We get that $\frac{\partial\pi^y(k)}{\partial k} < 0$ and $\frac{\partial\pi^x(k-1)}{\partial k} > 0$, which implies that $\frac{\partial F(k)}{\partial k} < 0$. This happens because license taken by a producer creates externalities on other producers. As the number of producers purchasing a license increases, it increases the number of producers producing *y*, thus reducing the profit of each producer producing *y*. On the other hand, as more producers switch to product *y*, the number of producers producing x decreases, thus increasing the profit of each producer producing x. It must be clear that these effects do not depend on our assumption that the products *x* and *y* are not substitutes. Instead, it happens because each producer produces either *x* or *y*. Hence, as the number of licensees increases, the net gain from becoming a licensee reduces, and therefore, the willingness to pay for a license reduces. Therefore, the innovator's maximum profit under fixed-fee licensing can be found by maximizing the following expression:

$$\underset{k}{Max}\, kF(k) = \underset{k}{Max}\, k\left(\frac{k^2b^2}{(k+1)^4} - \frac{(n-k+1)^2a^2}{(n-k+2)^4}\right) \tag{6}$$

subject to $\pi^y(k+1) - F(k) < \pi^x(k)$ or $F(k+1) < F(k)$.

Condition (6) says that the innovator wants to set up the fixed-fee $F(k)$ in a way so that only k firms find it profitable to take license, and the innovator's profit is maximized. Maximization of (6) gives the first order condition as

$$\frac{-b^2k^2(k-3)}{(k+1)^5} - \frac{a^2(n-k+1)^2}{(n-k+2)^4} - \frac{2a^2k(n-k)(n-k+1)}{(n-k+2)^5} = 0 \tag{7}$$

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[11] Under both fixed-fee licensing and auction, the innovator gets an up-front fee from the licensee. Since the up-front fee does not affect the output decisions of the producers, the equilibrium outputs of the producers under both fixed-fee licensing and auction follow immediately from the case of royalty licensing with r = 0.

It follows from (7) that the innovator always wants less than 3 producers to take license, since the left hand side (LHS) of (7) is negative for $k \geq 3$.

Proposition 1: *Suppose* $b > \frac{a(n+1)^2}{2n}$*. The profit of I is higher under royalty licensing than under fixed-fee licensing.*

Proof : If $b > \frac{a(n+1)^2}{2n}$, which implies that all firms purchase license under royalty licensing, LHS of (7) is positive for both $k = 1$, and $k = 2$, which implies that the innovator prefers to give two licenses under fixed-fee licensing.[12] Therefore, the innovator charges the fixed-fee $F(2) = \frac{(2bn^2 + 9a(n-1))(2bn^2 - 9a(n-1))}{81n^4}$, and only two producers buy the license whenever $n \geq 2$, since no more than 2 firms have the incentive to buy the license if the innovator charges $F(2)$. The profit of the innovator under fixed-fee licensing is

$$\pi_f^I = 2F(2) = \frac{2(2bn^2 + 9a(n-1))(2bn^2 - 9a(n-1))}{81n^4} \tag{8}$$

The comparison of (5) and (8) proves the result. ■

The above result shows that, in the presence of labor unions, royalty licensing can be the preferable strategy of the innovator compared to fixed-fee licensing even if there are positive opportunity costs of the producers, thus extending the result of Mukherjee (2009) to positive opportunity costs of the licensees.

Now consider auction. As described in Kamien et al. (1992), the difference between the fixed-fee licensing and auction lies in the difference in the opportunity costs of the producers. In the case of auction of k licenses, each licensee's opportunity cost of having the license is $\pi^x(k) = \frac{(n-k)^2 a^2}{(n-k+1)^4}$. Since $\pi^x(k) > \pi^X(k-1)$, for a given number of licenses, the opportunity costs of the producers are higher under auction than under fixed-fee licensing. Therefore, for the same number of licenses, the maximum willingness to pay by each producer is lower under auction than under fixed-fee licensing, which implies that, for a given number of licenses, the total profit of I is lower under auction than under fixed-fee licensing. Hence, it is easy to see that the equilibrium profit of I is higher under fixed-fee licensing than under auction,[13] which is in contrast to the existing works on licensing of process innovation by an outside innovator (Kamien and Tauman, 1984 and 1986, Kamien et al., 1992 and Sen, 2005a). The positive externality of licensing on the non-licensees (i.e., the remaining producers of x) is the reason for the higher profit of I under fixed-fee licensing compared with auction. In contrast, the existing literature with process innovation creates a negative externality on the non-licensees, thus reducing the profit of the innovator under fixed-fee licensing compared with auction.

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[12] This argument relaxes the assumption of no integer constraint.

[13] The argument is as follows. The equilibrium profit of I can only be higher under auction than under fixed-fee licensing if the number of licenses are different under these two licensing schemes, since for the same number of licenses, fixed-fee licensing generates

The following result summarizes the above discussion.

Proposition 2 : *The profit of I is lower under auction than under fixed-fee licensing.*

Combining Proposition 1 and Proposition 2, we get the following result.

Proposition 3 : *In the presence of labor union and the positive opportunity costs of the licensees, the profit of an outside innovator is higher under royalty licesning than under fixed-fee liensing, which provides a higher profit to the innovator than auction.*

Since the royalty licensing leaves surplus to the producers which can be extracted by imposing a fixed-fee, it is then immediate that a licensing scheme with both fixed-fee and royalty can be used to extract more profits from licensing compared with royalty only licensing.

A remark deserves attention at this point. Our assumption of single-product firms plays an important role in determining the effect of more licenses on the payoffs of the non-licensees. If the firms produce multiple products, more licenses may not affect the number of firms producing x, and therefore, may not create the above-mentioned positive externality on the producers of x. Hence, with multiple-product firms, auction is likely to dominate the fixed-fee licensing from the innovator's point of view. However, the wage-effects created by the labor unions for different types of licensing contracts remain even with multi-product firms, thus may help to make the innovator better off under royalty licensing compared with fixed-fee licensing and auction.

3. Conclusion

We cosnider a simple model to show an outside innovator's preference for royalty licensing, fixed-fee licensing and auction in the presence of labor union,

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higher profit for I compared to auction. Now assume that the equilibrium profit of I is higher under auction than under fixed-fee licensing. However, since the fee under fixed-fee licensing reduces with the number of licensees, I can always charge a fixed-fee that makes the number of licenses sold under fixed-fee licensing equal to the number of licenses under auction. Further, for the same number of licenses, the profit of I is higher under fixed-fee licensing than under auction. Hence, the initial fee charged under fixed-fee licensing is not the equilibrium fee, and it is not possible to have a higher equilibrium profit of I under auction than under fixed-fee licensing.

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when the opportunity costs of the licensees are positive. We show that auction is dominated by fixed-fee licensing, which is dominated by royalty liocensing. A licensing scheme with both fixed-fee and royalty can be preferred to the innovator than royalty only licensing.

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Education and Health : Strategic Sequencing in Social Development

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Abstract

Education and health are considered to be two vital sectors that can play a crucial role in determining the level of social development of a region. This paper analyzes the education and health scenario (in terms of both infrastructure and attainment) in fifteen major states of India by constructing suitable composite indices An attempt has also been made to study the inter-linkages between the education and health sectors. We find a high positive correlation not only between health infrastructure and health attainment, but also between health infrastructure and educational attainment. On the other hand, we not only observe a relatively weaker association between educational infrastructure and educational attainment, the association between educational infrastructure and health attainment is also very weak. Thus, in case of the health sector, both the direct and indirect effects are stronger compared to the education sector. This seems to indicate that in improving the overall quality of life in a poor country like India, the health sector plays a more fundamental role compared to the education sector. This calls for special attention and a greater share of resources for the health sector.

JEL classification code : 138, O15

Keywords : social development, strategic seqencing, infrastructure index, attainment index.

I. Introduction

The concept of development has undergone radical changes in the recent past and *social development* has come to acquire a new salience in development thinking. This new thinking on development, and particularly the space yielded to social development in it, was institutionalized at the global level through the "Summit Conference on Social Development" held in Copenhagen in 1995, and the "Declaration and Programme of Action" adopted at this Conference. Social development is now recognized both as a *means* to economic prosperity as well as an *end* in itself. It is concerned with the transformation of an entire society (involving its social processes, attitudes and institutions) in such a manner that it leads to a better "quality of life" for the people. In fact, the concept of *social development* is broader than the concept of *human development*. While human development focuses on the well-being of individuals in isolation, social development views the lives of individuals in relation to their social environment. It is concerned not only with the expansion of basic human capabilities but also with the level of social infrastructure, the nature of social institutions, the process of social change, and the like (Council for Social Development, 2006).

The level of social development of a region depends, to a large extent, on the performance of certain vital sectors that are collectively known as the *social sector*.

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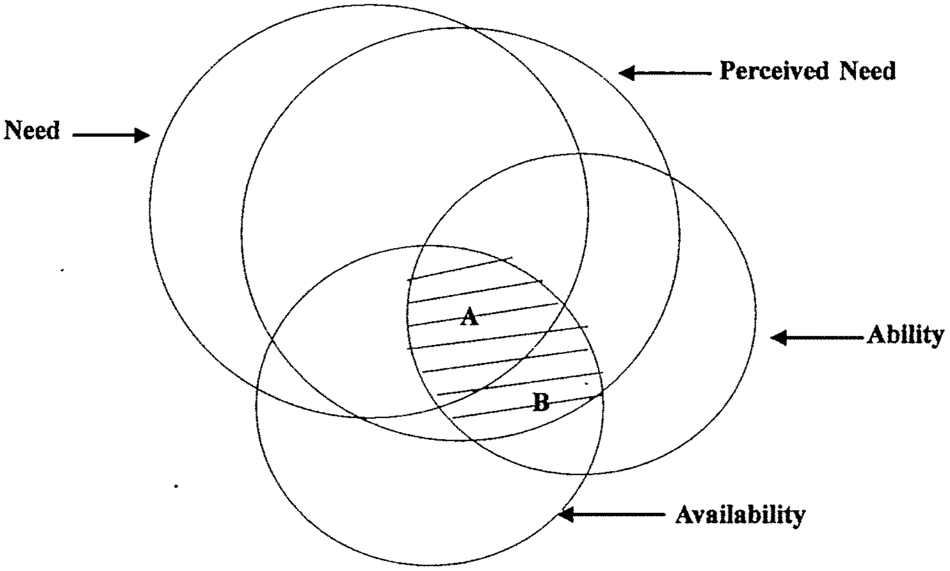
The term *social sector* is generally used to refer to all those sectors that are essential for improving the quality of life of the people. It encompasses sectors like education, health and nutrition, as well as sectors concerned with eradication of poverty and other programmes of social welfare (Prabhu, 2001). From a broader perspective, the issues related to gender discrimination, environmental degradation, etc. also come under the purview of social sector development. The development of this sector is very crucial since it provides the requisite framework for attaining a desired level of sustainable development. The Millennium Development Goals set at the World Summit on Sustainable Development (held at Johannesburg, South Africa in 2002) also emphasize the importance of social sectors.

Within the social sector, education and health are two vital areas that can be of great strategic importance in the process of social development. Dreze and Sen (1995) have identified education and health as two important "promoting" factors. They point out that in addition to being valuable achievements in themselves, a person's education and health can help her/him to do many other valuable things (e.g., to get a good job). They also argue that education and health can be important instruments of social change. Greater literacy and basic education increases public awareness and encourages collective demand for social services (e.g. for health care and social security). This not only facilitates expansion of public facilities but also contributes to better utilization of the available services. Dreze and Sen (1995) also emphasize that education and health can play important empowerment and distributive roles by increasing people's ability (especially of disadvantaged groups) to resist oppression, to be organized politically, and to get a fairer deal. The redistributive effects can be important not only between different social groups or households, but also within the family, since there is evidence that better education (particularly female education) contributes towards reduction of gender-based inequalities. We, therefore, observe that better education and health can play a crucial role in the process of social development through their various interconnections.

In this paper, an attempt has been made to explore this interconnectedness as would be evident from the state-level observations on India available over almost quarter of a century starting from 1981.

One of the fundamental aspects of social development is the ability of people to lead a *long and healthy life*. The "length" or "quantity" of a person's life can be measured in terms of the indicator *life expectancy at birth*. However, a person may survive many years with some chronic illness which may affect his/her "quality" of life. Hence, we need to consider the health status of the population (reflected in indicators like infant mortality rate, prevalence of acute and chronic illness, etc.). Chatterjee (1990) has pointed out that the health status of the people is generally determined by the intersection of four factors need, perception, ability and availability. Need for health services may depend on biological factors (like genetic factors) as well as socio-economic factors (like levels of living, environmental pollution, allocation of resources within the household, etc.). Perception of need is guided by the socio-economic and cultural factors like educational status of a person, income level and social background. The factors which affect perception also determine a person's ability to recognize the health need and get it attended. However, ability is necessary and not sufficient for the pro-active decisions. Successful utilization depends on the availability factor. Availability of healthcare facilities is reflected in the availability of physical infrastructural facilities like number of hospitals, dispensaries and beds as well as in the availability of health manpower like doctors and nurses per unit of the population. Moreover, in developing countries like India, majority of the population are dependent on public provisioning of health facilities. Since the primary objective of social sector development is to cater to the weaker section of the population, the contribution of the public sector in these areas assumes special significance.

Figure-I shows the interactive linkage among these four dimensions. Region A shows the intersection of the four factors, i.e., when actual need is both perceived and realized. On the other hand, region B shows the intersection of three factors - ability, perception and availability. That is, there is no actual need; only perceived need is realized. These two areas (A + B) together show the total utilization of healthcare services.



A: Actual need realized

B: Pseudo need realized

Figure-I: Determinants of Health Status
(Source: Chatterjee, 1990)

Doubtless to say that the perception of need for health services depends on the level of awareness that is influenced by the level of education. In fact, proper education is even essential for the proper utilization of healthcare services. One of the basic indicators of educational attainment is literacy rate. In this connection, adult and female literacy rates assume special significance because of their ability to affect the well-being of future generations. Children are more likely to attend school if their parents are literate. Educational attainment of children is generally assessed in terms of indicators like enrolment ratio and dropout rates in school. Although elementary education is one of the preconditions of development, educational attainments at higher levels are equally important for enabling people to lead a better quality of life.

As in case of the health sector, the level of attainment in the education sector depends both on the ability of people as well as the availability of educational facilities. The level of educational infrastructure is reflected in indicators like number of recognized educational institutions, number of teachers, etc per unit of the population. Here also it is important to take into account the public provisioning of such facilities. The level of attainment depends not only on the overall level of provisioning but also on the quality of provisioning. For example, quality of an educational institution might be assessed in terms of availability of basic amenities like pucca buildings, safe drinking water facility, proper toilet facilities, etc. Again, quality of teaching in a school may depend on factors like the pupil-teacher ratio (PTR), student-classroom ratio (SCR), proportion of professionally qualified teachers, etc.

Hence, we see that the development of the education and health sectors has several important dimensions which are reflected in a variety of indicators. In this paper, we have tried to focus on certain basic dimensions as outlined in Figure-II on the basis of some important indicators (shown in tables 1, 8 and 17).

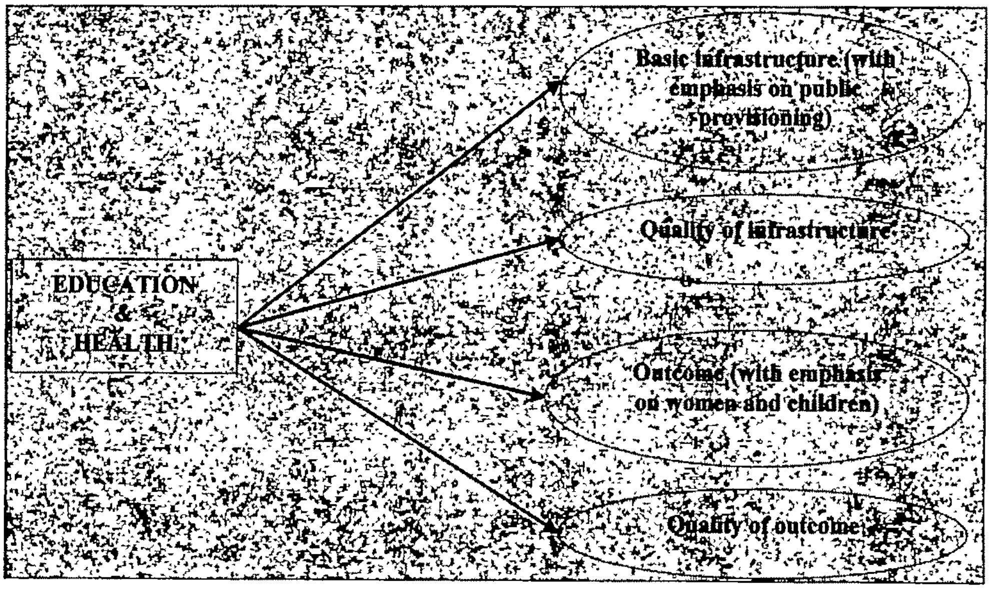

EDUCATION & HEALTH
Basic infrastructure (with emphasis on public provisioning)
Quality of infrastructure
Outcome (with emphasis on women and children)
Quality of outcome

Figure-II: Basic Dimensions of the Development of the Education and Health Sectors

The paper tries to analyze the education and health scenario (in terms of both infrastructure and attainment) in fifteen major states of India by constructing suitable composite indices. An attempt has also been made to study the inter-linkages between the education and health sectors. The states under study are — Andhra Pradesh (AP), Assam (ASM), Bihar (BIH), Gujarat (GUJ), Haryana (HAR), Karnataka (KAR), Kerala (KER), Madhya Pradesh (MP), Maharashtra (MAH), Orissa (ORS), Punjab (PUN), Rajasthan (RAJ), Tamil Nadu (TN), Uttar Pradesh (UP) and West Bengal (WB). These states together accounted for more than 90% of the total population and more than 85% of the total geographical area of India in 2001. The study covers the period 1981 to 2006.[1]

The paper is organized as follows. Section II discusses the method of construction of composite indices. Section III presents a detailed analysis of the health and education sectors on the basis of the composite indices. In this section, we have studied temporal changes in the relative positions of the states during the period 1981-2001. The analysis has been done primarily on the basis of census data and those obtained from some other government publications. The detailed data sources are given in Appendix I. This section also discusses the inter-linkages between the two sectors. In Section IV, we have revisited the health and education sectors. Here we have tried to make a deeper study of the health and education sectors on the basis of some recent data made available by the National Sample Survey Organization (2004), the third round of National Family Health Survey (2006) and the National University of Educational Planning and Administration (2009). A special set of indices has been estimated for the year 2006 by collating data from all these sources. Section V concludes the paper.

II : Construction of Composite Indices

In this section, we discuss the method of construction of the composite indices. Separate indices have been calculated to study the levels of infrastructure and attainment. Here attainment refers to achievements made in the fields of health and education as measured by indicators like life expectancy at birth, infant mortality rate, literacy rate, enrolment ratio, etc. Infrastructure refers to the provisioning of health and education facilities as measured by indicators like number of hospitals, number of teachers, number of educational institutions, etc. The health sector has been analyzed on the basis of the Health Attainment Index (HAI) and the Health Infrastructure Index (HII) and the education sector has been analyzed by computing the Education Attainment Index (EAI) and the Education Infrastructure Index (EII). The values of the indices have been calculated at three points in time - 1981, 1991 and 2001, using primarily Census data. In addition, a special set of indices has been estimated for the year 2006 on the basis of some recent data.

The following steps were followed for constructing the different composite indices.

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[1] Since the 1981 Census was not carried out in Assam, the indices could not be computed for Assam for the year 1981.

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In the first step, an achievement index was constructed for each indicator by using the following formula:

$$Z_{ij} = 1 - [(\text{Best } X_i - \text{Observed } X_{ij}) / (\text{Best } X_i - \text{Worst } X_i)]$$

In the next step, Principal Component Analysis was applied to determine the component loadings and component weights. However, we got almost equal weight for the indicators in most cases. Hence, following the practice adopted in the calculation of the Human Development Index, we have taken the simple arithmetic mean of the relevant achievement indices for estimating the composite indices. The analysis of the health and education sectors on the basis of these indices is presented in the following section.

III: What do the Composite Indices Reveal?

This section presents a detailed analysis of the health and education sectors in the fifteen major states of India during the period 1981-2001.

3.1: Analysis of the Health Sector

The health sector has been analyzed on the basis of HII and HAI. Table 1 shows the list of indicators used for the construction of HII and HAI.

Table 1: Indicators Used for Construction of HII and HAI

Index (Col.1)	Indicators used for the construction of the indices for 1981, 1991 and 2001 (Col.2)
HII	• X1 - Number of hospitals (excluding private hospitals) per 100,000 population
	• X2 - Number of dispensaries (excluding private dispensaries) per 100,000 population
	• X3 - Number of beds (excluding private beds) per 100,000 population
	• X4 - Number of doctors per 100,000 population
	• X5 - Number of nurses per 100,000 population
HAI	• X6 - Life expectancy at birth
	• X7 - Infant Survival Rate (ISR)

The values of the indicators for health infrastructure are shown in tables 2a and 2b. From Table 2a, we observe that the availability of hospitals, dispensaries and beds per unit of population has gone down in most of the states during the period 1981-2001. This indicates that, in general, increase in physical infrastructural facilities has not kept pace with population growth. In fact, no state shows a sustained rise in such facilities per unit of population consistently over the reference period (1981-2001). However, the situation seems less grim in terms of availability of health manpower per unit of population. Almost all states have managed to increase their availability of health manpower over this period. But it is to be noted that the availability of health manpower per unit of population is very low especially for states like HAR, MP and UP. In order to study the relationship between the two components of health infrastructure - physical and human - we have constructed two sub-indices (using the same methodology as mentioned in Section II). These are the Physical Infrastructure Index (PII) and the Health Manpower Index (HMI) as reported in tables 2a and 2b respectively.

Table 2a: Availability of physical infrastructure in the health sector

	1981				1991				2001			
	X1	X2	X3	PII	X1	X2	X3	PII	X1	X2	X3	PII
AP	0.652	1.412	47.76	0.164	0.223	0.152	46.07	0.148	0.437	0.177	36.43	0.239
ASM	0.554	2.322	49.96	0.170	0.839	1.414	47.43	0.440	0.706	1.190	40.05	0.466
BIH	0.296	2.464	39.40	0.061	0.276	0.494	23.93	0.103	0.287	0.515	24.94	0.122
GUJ	0.625	1.367	57.77	0.182	0.821	1.026	62.18	0.469	0.743	0.852	52.70	0.522
HAR	0.457	1.068	38.23	0.062	0.358	1.069	32.18	0.191	0.289	0.611	24.61	0.128
KAR	0.533	4.026	75.76	0.296	0.527	1.821	64.11	0.405	0.449	1.491	56.20	0.404
KER	0.605	2.043	152.92	0.473	0.485	0.186	96.89	0.431	0.003	0.170	96.13	0.496
MP	0.583	0.939	39.22	1.000	0.548	0.387	27.41	0.211	0.157	0.171	17.92	0.000
MAH	0.675	2.373	92.19	0.332	0.674	1.053	53.21	0.383	0.437	0.837	58.98	0.372
ORS	1.062	0.978	42.35	0.266	1.128	3.481	44.29	0.633	0.706	3.414	32.86	0.560
PUN	1.328	10.596	111.04	0.880	0.878	7.149	80.60	0.848	0.741	6.069	68.70	0.884
RAJ	0.601	3.351	56.41	0.239	0.495	0.643	47.73	0.278	0.200	0.475	31.15	0.097
TN	0.688	1.324	73.26	0.246	0.517	0.865	69.09	0.374	0.465	0.781	62.14	0.398
UP	0.520	1.516	36.90	0.094	0.414	1.208	29.40	0.208	0.347	1.012	24.63	0.184
WB	0.524	0.896	86.00	0.215	0.386	0.718	70.29	0.323	0.345	0.223	60.45	0.291

Source: Calculated on the basis of secondary data (data sources given in Appendix I)

Table 2b: Availability of health manpower

	1981			1991			2001		
	X4	X5	HMI	X4	X5	HMI	X4	X5	HMI
AP	43.05	20.32	0.240	50.17	22.94	0.241	58.86	103.61	0.479
ASM	40.09	14.33	0.194	46.84	12.74	0.189	54.76	33.16	0.261
BIH	26.30	11.09	0.121	30.54	10.45	0.116	39.90	10.72	0.139
GUJ	42.99	14.45	0.207	54.21	16.65	0.233	66.51	137.43	0.606
HAR	1.98	13.97	0.041	3.91	17.68	0.040	5.44	63.73	0.154
KAR	51.05	13.94	0.236	72.95	20.54	0.322	115.98	145.93	0.825
KER	45.95	37.48	0.350	66.89	137.53	0.747	94.77	184.62	0.852
MP	8.07	15.52	0.074	16.90	16.65	0.087	31.50	144.67	0.488
MAH	65.43	54.03	0.521	62.54	45.72	0.377	83.48	106.17	0.583
ORS	30.67	11.26	0.139	35.02	13.28	0.145	39.00	104.76	0.404
PUN	127.88	94.56	1.000	131.33	103.07	0.868	132.38	152.27	0.908
RAJ	25.43	15.33	0.142	31.91	17.52	0.149	36.19	44.91	0.222
TN	65.68	51.75	0.509	83.10	54.43	0.492	105.89	166.75	0.845
UP	21.54	6.78	0.078	23.85	7.33	0.078	25.57	9.74	0.079
WB	60.15	16.23	0.285	61.29	18.44	0.268	62.25	53.64	0.349

Source: Calculated on the basis of secondary data (data sources given in Appendix I)

Table 3 shows the values of the correlation coefficients between the two components of health infrastructure - the Physical Infrastructure Index (PII) and the Health Manpower Index (HMI). Row-wise reading of Table 3 suggests that the availability of human resources at an earlier phase reveals stronger correlation with physical infrastructure at subsequent phases indicating the effective role of human initiative in this regard. However, sheer availability of physical infrastructure without any reference to its adequacy or quality fails to generate any favourable influence on the availability of trained health personnel.

Table 3: Correlation between PII and HMI

	PII, 1981	PII, 1991	PII, 2001
HMI, 1981	0.476	0.659*	0.747*
HMI, 1991		0.625*	0.746*
HMI, 2001			0.651*

Source: Estimated on the basis of tables 2a and 2b
*Correlation is significant at 0.05 level (2-tailed)

Table 4 shows the values of the indicators for health attainment. We observe that the expectation of life at birth has gone up in all states during 1981-2001. KER and PUN maintained their superiority throughout the period of study. Quite expectedly, the infant survival rate (ISR) has gone up in almost all the states during the period, the exceptions being AP and HAR. However, an alarming feature is that, even in 2001, the rate of infant survival is low in many states, especially in states like ORS, MP, UP and RAJ.

Table 4: Indicators for HAI (1981, 1991, 2001)

	X6 (Life Expectancy at Birth)			X7 (ISR)		
	1981	1991	2001	1981	1991	2001
AP	58.4	61.8	63.9	909	945	934
ASM	51.9	55.7	59.9	-	908	922
BIH	52.9	59.3	65.2	906	925	933
GUJ	57.6	61.0	63.6	885	922	936
HAR	60.3	63.4	67.0	874	948	931
KAR	60.7	62.5	64.4	919	926	942
KER	68.4	72.9	73.3	946	958	984
MP	51.6	54.7	58.6	850	867	903
MAH	60.7	64.8	68.4	881	926	951
ORS	53.0	56.5	59.9	837	875	902
PUN	63.1	67.2	71.0	873	926	946
RAJ	53.5	59.1	62.5	859	913	917
TN	56.9	63.3	68.4	896	946	947
UP	50.0	56.8	63.8	870	901	915
WB	57.4	62.1	67.7	905	938	947

Source: Same as in Table 2a and 2b

Table 5 shows the values of the correlation coefficients between Life Expectancy at Birth (X6) and Infant Survival Rate (X7). As expected, the values of the coefficients are high and are statistically significant too.

Table 5: Correlation between X6 and X7

	X7 (1981)	X7 (1991)	X7 (2001)
X6 (1981)	0.639*	0.712*	0.869*
X6 (1991)	0.689*	0.794*	0.941*
X6 (2001)	0.642*	0.803*	0.913*

Source: Estimated on the basis of Table 4

*Correlation is significant at 0.05 level (2-tailed)

We now take a look at the overall situation in terms of HII and HAI (confer Table 6). We observe that, with respect to HII, PUN and KER occupied the top two places during the entire period 1981-2001 while BIH, HAR and UP consistently showed low ranks. GUJ has consistently improved its rank while MAH, RAJ and WB show continuous deterioration. It has also been found that in 1981 only one state (PUN) had an absolute value of HII in excess of 0.5. The number increased to five in 2001.

In terms of HAI, KER once again is the top performer for the entire period. GUJ (ninth) and ORS (fourteenth) also maintained their relative positions reflected in unchanged ranks. AP, KAR and MP show deterioration in rank throughout the period while BIH, HAR, PUN and TN show improvement. When we compare the absolute values of HAI over time, we find that two states show decline in absolute value during the period 1981-91 while as many as ten states show decline during 1991-2001. Moreover, in 1981, there were five states having absolute value of HAI greater than 0.5. In 1991, there were eight such states whereas in 2001, this figure again dropped to five. This fluctuating performance does not indicate very strong association between infrastructure and attainment in health sector (confer Table 7)[2]

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[2] It will be shown later that this association between infrastructure and attainment is even more weak for the education sector.

Table 6: The Health Sector

	HII						HAI					
	1981		1991		2001		1981		1991		2001	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
AP	0.194	9	0.185	11	0.335	9	0.559	3	0.624	5	0.375	10
ASM	-	-	0.340	8	0.384	8	-	-	0.253	12	0.167	13
BIH	0.085	13	0.108	15	0.129	15	0.395	10	0.445	10	0.414	8
GUJ	0.192	10	0.374	6	0.555	5	0.427	9	0.475	9	0.377	9
HAR	0.053	14	0.130	14	0.138	14	0.450	8	0.684	2	0.461	6
KAR	0.272	5	0.372	7	0.572	4	0.667	2	0.538	8	0.442	7
KER	0.423	2	0.558	2	0.638	2	1.000	1	1.000	1	1.000	1
MP	0.090	11	0.161	12	0.194	11	0.103	13	0.000	15	0.006	15
MAH	0.408	3	0.381	5	0.456	7	0.493	6	0.602	6	0.630	3
ORS	0.215	7	0.438	3	0.498	6	0.082	14	0.093	14	0.043	14
PUN	0.928	1	0.856	1	0.893	1	0.521	4	0.668	4	0.685	2
RAJ	0.200	8	0.226	10	0.147	12	0.196	11	0.374	11	0.223	12
TN	0.351	4	0.421	4	0.577	3	0.458	7	0.670	3	0.606	4
UP	0.087	12	0.156	13	0.142	13	0.151	12	0.245	13	0.256	11
WB	0.243	6	0.301	9	0.314	10	0.513	5	0.593	7	0.583	5

Source: Calculated on the basis of secondary data (data sources given in Appendix I)

Row-wise reading of Table 7 shows that infrastructure, once developed, has long run influence on improving the health status whereas column-wise reading suggests only weak association between present attainment and past infrastructure. These two observations taken together indicate that adequate provision of infrastructure is necessary but not sufficient to guarantee good health status. In fact, states that have done well with respect to infrastructure have not always shown good performance with respect to attainment.

Table 7: Correlation between HII and HAI

	HAI 1981	HAI 1991	HAI 2001
HII 1981	→ 0.413	→ 0.455	→ 0.579*
HII 1991	×	→ 0.375	→ 0.527
HII 2001	×	×	0.536*

Source: Estimated on the basis of Table 6

*Correlation is significant at 0.05 level (2-tailed)

Here, it should be noted that the health indicators under consideration are absolutely state-specific. However, in the face of a growing tendency for medical tourism, the health status of one state may be connected with the quality of infrastructural provision available in other states. Another source of discomfort in this context is an absence of any significant change in the overall scenario following the introduction of structural reform initiatives. To study the situation in greater detail, Section IV presents a more updated analysis in terms of information available till 2006.

3.2: Analysis of the Education Sector

We now turn to the education sector. Table 8 shows the list of indicators used for the construction of EII and EAI while tables 9 and 11 show the values of these indicators.

Table 8: Indicators Used for Construction of EII and EAI

Index (Col.1)	**Indicators used for the construction of the indices for 1981, 1991 and 2001 (Col.2)**
EII	• **Y1** - Number of recognized educational institutions per 100,000 population in age-group 5-24 years • **Y2** - Number of teachers in recognized educational institutions per 100,000 population in age-group 5-24 years • **Y3** - Average of Pupil-Teacher Ratio (PTR) in primary, upper primary, secondary and senior secondary stages
EAI	• **Y4** - Adult Literacy Rate • **Y6** - Gross Enrolment Ratio (GER) for classes I-VIII • **Y7** - Gross Dropout Rate (GDR) for classes I-VIII

Let us first take a look at the state of educational infrastructure. Table 9 shows the values of the indicators used for constructing EII for the years 1981, 1991 and 2001. We observe that ASM and MP showed good performance in terms of availability of both educational institutions (Y1) and teachers (Y2). Interestingly, KER shows poor performance in terms of availability of educational institutions but much better performance in terms of availability of teachers. It is also to be noted that the values of Y1 and Y2 have gone down in many states during the period 1981-2001. In terms of average pupil-teacher ratio (Y3), most states show values less than or equal to 40 (considered to be an ideal value in some studies). However, in 2001, BIH and WB showed much higher values of Y3.

Table 9: Indicators used for estimating EII (1981, 1991, 2001)

	Y1(Institutions)			Y2 (Teachers)			Y3 (PTR)		
	1981	1991	2001	1981	1991	2001	1981	1991	2001
AP	248.63	251.92	269.46	767.12	967.83	941.53	42	43	38
ASM	-	479.79	381.59	-	1682.19	1713.19	27	30	29
BIH	241.58	268.18	200.83	804.28	848.42	815.33	35	41	49
GUJ	236.61	252.39	197.34	984.73	1371.95	1007.87	35	34	44
HAR	177.14	121.97	180.36	957.42	1157.56	1112.95	35	37	29
KAR	296.34	299.74	260.80	992.91	1180.94	1304.68	35	41	38
KER	105.08	106.92	106.72	1566.29	1791.24	1662.26	30	29	25
MP	332.48	347.80	372.02	967.34	1198.75	2404.45	31	33	33
MAH	248.43	291.60	218.00	1319.98	1564.57	1487.77	31	36	41
ORS	403.74	423.85	391.95	1138.20	1445.03	1396.33	25	27	37
PUN	247.14	195.51	184.60	1338.89	1385.71	1200.32	26	29	29
RAJ	239.42	240.96	247.94	902.87	1208.51	1135.15	32	31	40
TN	234.98	222.15	178.48	1077.09	1485.30	2813.35	34	39	35
UP	206.50	227.46	163.04	943.54	921.92	1335.52	35	44	39
WB	265.90	302.92	184.14	1051.21	1236.67	917.26	39	38	51

Source: Calculated on the basis of secondary data (data sources given in Appendix I)

Table 10 presents the correlations between the variables shown in Table 9. We observe low correlations between the Y1 and Y2 and that between Y1 and Y3. This low-level of association between the indicators of physical infrastructure and human resources involved in the delivery system of education services is rather disturbing. However, the correlations are stronger between Y2 and Y3 with an expected negative sign. So, at the infrastructure level human factors are playing more dominant role than the physical aspects.

Table 10: Correlations among Y1, Y2 and Y3

	Y2 (1981)	Y2 (1991)	Y2 (2001)	Y3 (1981)	Y3 (1991)	Y3 (2001)
Y1 (1981)	- 0.285	- 0.157	0.095	- 0.255	- 0.157	0.304
Y1 (1991)	- 0.275	0.119	0.131	- 0.315	- 0.210	0.203
Y1 (2001)	- 0.326	0.055	0.204	- 0.366	- 0.323	- 0.082
Y2 (1981)				- 0.630*	- 0.615*	- 0.517
Y2 (1991)				- 0.618*	- 0.711*	- 0.517*
Y2 (2001)				- 0.319	- 0.168	- 0.454

Source: Estimated on the basis of Table 9
*Correlation is significant at 0.05 level (2-tailed)

Table 11 presents the indicators used for studying the state of educational attainment in the major states of India. From Table 11, we observe that in terms of adult literacy rate, KER has been the top performer during the entire period 1981-2001 while BIH has remained at the bottom throughout. We also observe that all states achieved some improvement in terms of their adult literacy rates during the period 1981-2001 (substantial improvement observed for ASM and TN during the period 1991-2001). In terms of GER also, we find that all states improved their situations during the period 1981-2001. In 2001, MAH had the highest GER followed by GUJ and TN. However, UP and BIH show low values of GER even in 2001. In terms of dropout rate, KER shows zero dropout rate for the year 2001 followed by HAR (12.35). It is noteworthy that the dropout rate is quite high in most states even in 2001 more than 70% in BIH and WB). Such high dropout rates in classes I-VIII is a major area of concern.

Table 11: Indicators used for estimating EAI (1981, 1991, 2001)

	Y4 (Adult Literacy)			Y5 (GER)			Y6 (GDR)		
	1981	**1991**	**2001**	**1981**	**1991**	**2001**	**1981**	**1991**	**2001**
AP	32.50	38.51	50.9	43.10	54.45	78.15	76.50	75.94	63.09
ASM	-	49.58	74.8	-	54.70	94.00	-	69.22	69.21
BIH	29.37	35.13	48.4	37.85	42.70	60.25	80.40	78.61	74.79
GUJ	48.26	55.88	68.2	58.05	65.20	96.75	67.20	58.36	52.52
HAR	39.21	48.92	64.9	51.90	67.65	70.30	44.90	35.56	12.35
KAR	43.05	50.94	61.8	49.00	62.55	93.30	75.10	61.09	50.99
KER	78.11	88.00	90.6	86.85	92.15	93.50	23.00	2.40	0.00
MP	35.63	40.02	54.4	39.15	52.35	85.25	68.00	53.52	50.11
MAH	51.84	60.37	72.9	62.05	72.40	99.20	70.60	51.21	37.03
ORS	38.72	46.10	58.8	45.20	55.50	84.30	82.90	69.24	60.74
PUN	42.65	52.90	68.5	62.80	69.65	71.55	59.70	45.37	36.99
RAJ	28.20	35.53	47.6	36.95	45.55	94.60	70.10	81.88	53.56
TN	50.38	57.02	70.7	60.10	74.75	95.85	65.20	38.85	40.07
UP	30.76	38.62	52.2	38.85	44.00	50.80	77.30	48.39	60.11
WB	48.10	56.19	67.5	49.35	53.50	81.85	73.80	74.29	70.87

Source: Same as in Table 9

Table 12 presents the correlations between the variables shown in Table 11. In general, we observe high correlations between the adult literacy rate and GER which is a positive sign, indeed, as an increase in adult awareness would definitely prompt better school-going habit among the children. Again, an improvement in the perceived demand for education will not only enhance GER but also simultaneously discourage dropouts. This is getting reflected in the strong negative correlation between GER and GDR.

Table 12: Correlations among Y4, Y5 and Y6

	Y5 (1981)	Y5 (1991)	Y5 (2001)	Y6 (1981)	Y6 (1991)	Y6 (2001)
Y4 (1981)	0.947*	0.900*	0.517	- 0.729*	- 0.758*	- 0.678*
Y4 (1991)	0.962*	0.905*	0.471	- 0.751*	- 0.763*	- 0.686*
Y4 (2001)	0.968*	0.866*	0.491	- 0.743*	- 0.709*	- 0.612*
Y5 (1981)				- 0.785*	- 0.809*	- 0.771*
Y5 (1991)				- 0.783*	- 0.830*	- 0.837*
Y5 (2001)				- 0.201	- 0.077	- 0.209

Source: Estimated on the basis of Table 11
*Correlation is significant at 0.05 level (2-tailed)

We now take a look at the overall position with respect to educational infrastructure and educational attainment on the basis of the composite indices. Table 13 shows the values of EII and EAI (constructed by using the indicators given in Table 8) along with the corresponding ranks of the states on the basis of these indices. The values of the indices are shown at three points in time - 1981, 1991 and 2001.

We observe that in 1981, ORS, PUN and MAH were the top-performing states with respect to EII followed by KER and MP. BIH, HAR and AP were the worst performers. When we look at the position of the states with respect to EII for the year 1991, we find that ASM occupies the top position followed by ORS and MAH. However, PUN, which occupied the *second* position in 1981, has fallen back to the *sixth* position. BIH, AP and UP occupied the bottom three slots in 1991. In the year 2001, we again observe considerable change in the relative position of the states. MP, which occupied the *fifth* place in 1981 and 1991, has moved to the *first* place in 2001 while KER, which occupied the *fourth* place in 1981 and 1991, has fallen back to the *sixth* place in 2001. Another noticeable change is that MAH has slipped to the *eleventh* place from *third* place in 1981 and 1991. TN has improved its position to move into the *fourth* place while WB has moved down from the *ninth* position in 1991 to the *fifteenth* position in 2001. If we look at the absolute value of the indices, we observe that 5 states in 1981, 7 states in 1991 and 4 states in 2001 had absolute value of EII greater than or equal to 0.5. Moreover, 5 states show decline in absolute value of EII during the period 1981-91 while 9 states show decline during the period 1991-2001.

Table 13: The Education Sector

	EII						EAI					
	1981		1991		2001		1981		1991		2001	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank
AP	0.186	14	0.246	14	0.398	10	0.188	11	0.125	13	0.266	13
ASM	-	-	0.866	1	0.740	2	-	-	0.225	9	0.533	6
BIH	0.300	12	0.249	13	0.207	14	0.116	14	0.014	15	0.071	15
GUJ	0.387	9	0.517	7	0.281	13	0.431	5	0.381	6	0.575	4
HAR	0.283	13	0.272	12	0.406	9	0.419	6	0.449	4	0.547	5
KAR	0.429	6	0.390	11	0.448	5	0.304	8	0.321	7	0.509	7
KER	0.542	4	0.596	4	0.430	6	1.000	1	1.000	1	0.961	1
MP	0.534	5	0.545	5	0.815	1	0.217	10	0.215	10	0.400	9
MAH	0.566	3	0.602	3	0.396	11	0.467	2	0.488	3	0.698	2
ORS	0.766	1	0.789	2	0.627	3	0.218	9	0.208	11	0.380	12
PUN	0.649	2	0.528	6	0.425	7	0.455	4	0.447	5	0.473	8
RAJ	0.356	10	0.467	8	0.416	8	0.144	13	0.022	14	0.396	10
TN	0.407	7	0.455	10	0.626	4	0.466	3	0.535	2	0.644	3
UP	0.324	11	0.214	15	0.320	12	0.145	12	0.171	12	0.101	14
WB	0.399	8	0.466	9	0.182	15	0.345	7	0.237	8	0.386	11

Source: Calculated on the basis of secondary data (data sources given in Appendix I)

We now turn to the state of educational attainment. In 1981, KER, MAH and TN were the best-performing states on the basis of EAI. UP, RAJ and BIH were the worst performers. In 1991, the relative positions of the states do not show any drastic changes. In 2001, PUN moved down to the *eighth* position from the *fifth* position in 1991 while RAJ moved up to the *tenth* position from the *fourteenth* position of previous decade. Again, ASM improved its position from *ninth* in 1991 to sixth in 2001. It is interesting to note that, in terms of absolute value of EAI, only KER had absolute value in excess of 0.5 in 1981 while in 1991, only KER and TN had value of EAI greater than 0.5. However, in 2001, seven states show value of EAI greater than 0.5. In terms of change in absolute value of EAI, seven states show decline in absolute value during 1981-91 while only two states shows decline during 1991-2001.

It is also observed that states which occupy relatively good positions with respect to EII do not necessarily have good ranks on the basis of EAI and vice versa. This is reflected in the relatively low values of the correlation coefficients between EII and EAI in Table 14.

Table 14: Correlation between EII and EAI

	EAI 1981	EAI 1991	EAI 2001
EII 1981	0.310	0.343	0.379
EII 1991	×	0.364	0.539*
EII 2001	×	×	0.239

Source: Estimated on the basis of Table 13
*Correlation is significant at 0.05 level (2-tailed)

From the table, we observe that educational infrastructure generally influences attainment with a time lag. That is why the correlation coefficients between EII & EAI for the same year are, in general, weaker than the lagged correlation coefficients. This is understandable because the quantity of infrastructure does not disclose the quality of provision or the level of utilization and in the face of significant quality uncertainty, the results would be rather unrelated. So, in general, absence of strong relationship between infrastructure and attainment would indicate the possibility of quality failure.

3.3: Inter-Linkages Between the Education and Health Sectors

In this section, we try to study the inter-linkages between the education and health sectors and to see if there exist any significant differences in their pattern of influencing the overall level of social development. We also take a look at the nature of relationship between infrastructure and attainment in the two sectors. Table 15 shows the values of the simple correlation coefficients between the attainment indices of education and health. We find that there exists strong correlation between health attainment and educational attainment. This is obvious because education and health reinforce each other. Healthy children have better reception and retention, and therefore, attainment in health sector affects that in education favourably. Again, better education creates greater awareness leading to greater consciousness about hygiene and sanitation leading to improvement in health status.

Table 15: Correlation between EAI & HAI

	HAI (1981)	HAI (1991)	HAI (2001)
EAI (1981)	0.776	0.747	0.819
EAI (1991)	0.716	0.692	0.771
EAI (2001)	0.628	0.607	0.636

Source: Estimated on the basis of tables 6 and 13
(All correlations are significant at 5% level)

Table 16: Correlation between Infrastructure and Attainment

	EAI 1981	EAI 1991	EAI 2001	HAI 1981	HAI 1991	HAI 2001
EII 1981				- 0.090	- 0.192	0.019
EII 1991				×	- 0.134	0.013
EII 2001				×	×	- 0.374
HII 1981	0.471	0.462	0.413			
HII 1991	×	0.585*	0.544*			
HII 2001	×		0.579*			

Source: Estimated on the basis of tables 6 and 13
*Correlation is significant at 0.05 level (2-tailed)

Table 16 shows the values of the simple correlation coefficients between the infrastructure and attainment indices for the education and health sectors. From the table, we observe that the correlation between educational infrastructure and health attainment is almost negligible whereas that between health infrastructure and educational attainment is remarkably strong. For example, the correlation coefficient between EII(1981) and HAI(1981) is -0.090 while that between HII(1981) and EAI(1981) is 0.471. This seems to indicate that investment in health infrastructure not only influences the direct attainment in the health sector but also imparts significant indirect influence on the education sector.

IV: Further Updates on the Health and Education Sectors

The broad indicator-based analysis presented so far, which are mostly rooted in census data, has its intrinsic limitations. These are becoming even more glaring in recent days after the introduction of structural adjustment programme at the aggregate economy level whereby private partnership initiatives are accommodated even in the provision of basic social services like health and education. National Family Health Survey (NFHS) is getting conducted periodically with additional information available on socio-cultural practices like the number of births attended by health professionals, share of institutional deliveries, percentage of women and children suffering from anaemia, etc. along with the standard indicators already considered. In infrastructural provision also information is provided on public-private funding divisions. Similarly on education, the NUEPA has reported extensive district-level information on infrastructure and attainment indicators, sensitizing them from both public-private financial sources as well as gender perspective. Hence, some additional state-level indicators are incorporated for 2006 (Table 17).

Table 17: Indicators Used for Construction of EII and EAI for 2006

Index (Col.1)	HEALTH (Col.2)	EDUCATION (Col.3)
Infrastructure	• U1- No. of hospitals (excluding private hospitals) per lakh population • U2 - No. of dispensaries (excluding private dispensaries) per lakh population • U3 - No. of beds (excluding private beds) per lakh population (BED) • U4 - No. of doctors per lakh population • U5 - No. of nurses per lakh population • U6 - Proportion of births attended by health professionals • U7 - Proportion of births delivered in medical institutions • U8 - Percentage of children (12-23 months) fully vaccinated	• W1 - Percentage of govt. schools among recognized schools imparting elementary education • W2 - Primary schools per thousand child population (6-11 years) • W3 - Upper primary schools per thousand child population (11-14 years) • W4 - Percentage of professionally trained teachers • W5 - Average PTR • W6 - Average student-classroom ratio (SCR) • W7 - Percentage of schools having pucca buildings • W8 - Percentage of schools having drinking water facility in school • W9 - Percentage of schools having girls' toilet in school
Attainment	• U9 - Life Expectancy at Birth • U10 - Infant Survival Rate • U11 - Percentage of women (15-49 years) with anaemia • U12 - Percentage of children with anaemia • U13 - Persons reporting ailment during the last 15 days (number per 1000) • U14 - Persons suffering from ailment on the day before the date of survey (number per 1000)	• W10 - GER (Classes I-VIII) • W11 - Gender Parity Index (GPI) in enrolment for classes I-VIII • W12 - Dropout rate at primary level • W13 - GER in higher education • W14 - Percentage of literates with qualification "Graduate and above"

Table 18 shows the values of the additional indicators used for analyzing the health sector for the year 2006. The three additional (health) infrastructure indicators selected (U6, U7 and U8) are related to the spread of *institutional deliveries* and *immunization*. Frankly speaking, they are not standard representation of infrastructures, but they can proxy the quality of available facilities truly. The first two would help to assert maternal complications including mortality whereas the latter one would improve child survival rate. Hence, we have treated them as infrastructure indicators. We observe that in terms of all three indicators KER has been the top performer followed by TN. On the other hand, ASM, BIH and UP show poor performance in terms of all three indicators.

Table 18 also shows the values of the additional indicators (U11, U12, U13 and U14) used for analyzing the level of health attainment. From NFHS-3 data we have selected some state-level health indicators to reflect morbidity status. Morbidity related additional indicators show that even in our best-performing states like KER and PUN, the percentage share of anemic children is no less than 44. Generally, reported morbidity and mortality ranks vary inversely as early intervention saves case fatality rates. This pattern is supported by our state-level data and the lowest mortality state KER is showing highest reported morbidity, indicating higher level of awareness.

Table 18: Additional Indicators Used for the Health Sector

	Infrastructure			Attainment			
	U6	**U7**	**U8**	**U11**	**U12**	**U13**	**U14**
AP	0.651	0.500	52.0	62.9	70.8	96	67
ASM	0.215	0.176	17.0	69.5	69.6	82	36
BIH	0.235	0.147	10.6	67.4	78.0	54	27
GUJ	0.535	0.464	48.3	55.3	69.7	72	49
HAR	0.420	0.223	62.7	56.1	72.3	93	58
KAR	0.592	0.511	60.0	51.5	70.4	62	40
KER	0.941	0.930	79.2	32.8	44.5	251	178
MP	0.301	0.204	22.4	56.0	74.1	62	36
MAH	0.597	0.528	78.2	48.4	63.4	103	65
ORS	0.337	0.229	43.7	61.2	65.0	75	33
PUN	0.627	0.375	72.1	38.0	66.4	127	85
RAJ	0.362	0.217	16.0	53.1	96.7	60	40
TN	0.841	0.798	78.2	53.2	64.2	95	60
UP	0.230	0.157	21.2	49.9	73.9	102	63
WB	0.445	0.404	43.1	63.2	61.0	124	82

Source: NFHS-3 and NSSO (2004)

Next, we turn to the educational sector. Table 17 presents the list of indicators used for studying the level of development of the education sector while the values of the indicators are reported in Table 19. First we take a look at the state of educational infrastructure in the major states of India for the year 2006. Data for the nine indicators (W1 to W9) has been gathered from NUEPA (2009). The values of the indicators are for the year 2006-07. Some interesting features can be observed from Table 19. The first indicator (W1) shows the proportion of government schools among recognized schools imparting elementary education. This indicator has been considered in view of the fact in a developing country like India, majority of the population is dependent on public provisioning of education and health facilities. We find that government schools account for the major share (more than 75%) in all states except KER, TN and MAH. It is to be noted that KER, with the lowest proportion (41.07%) of government schools, has the highest literacy rate. TN and MAH also have relatively high levels of educational attainment. On the other hand, BIH has the highest proportion of government schools (98.45%) but shows poor levels of educational attainment. This raises questions regarding the *quality* of these schools. The next two indicators (W2 & W3), showing availability of schools per thousand child population, have been considered for assessing the access children have to primary and upper primary schools. We have tried to assess the *quality of teaching* in terms of W4, W5 and W6. It is found that availability of professionally trained teachers is highest in KAR (almost hundred percent) followed by KER, GUJ and TN. On the other hand, proportion of professionally trained teachers is quite low in the states of ASM, MP and BIH. In case of pupil-teacher ratio (PTR) and student-classroom ratio (SCR), the study by NUEPA (2009) has considered "40" as an ideal value for both indicators. We observe that the average values of PTR and SCR are less than 40 in most states except BIH, UP and WB. The last three indicators (W7, W8 and W9) show the proportion of schools having basic amenities like *pucca* buildings, drinking water facility in school and separate toilet for girls. We find that the overall provisioning of these basic amenities is relatively good in states like GUJ, HAR, KER, MAH, PUN and UP. The other states show a mixed picture. It is noteworthy that in terms of W9, most states (except HAR, KER, PUN and UP) show a bleak picture indicating the persisting neglect of the needs of the girl child.

Table 19: Indicators used for analyzing the education sector

	Infrastructure									Attainment				
	W1	**W2**	**W3**	**W4**	**W5**	**W6**	**W7**	**W8**	**W9**	**W10**	**W11**	**W12**	**W13**	**W14**
AP	80.09	11	7	85.23	22	27	38.11	80.00	42.53	88.68	0.95	5.42	9.51	48
ASM	83.23	16	7	39.77	25	41	32.95	61.77	10.02	95.36	0.98	9.32	8.67	31
BIH	98.45	4	3	62.78	64	91	68.96	90.20	16.21	70.74	0.78	9.34	7.30	33
GUJ	85.59	7	8	96.03	35	36	81.10	85.60	61.41	79.80	0.85	5.75	9.65	61
HAR	88.70	5	4	88.85	32	27	93.98	93.87	76.19	60.32	0.92	11.94	10.56	71
KAR	80.99	10	8	99.85	32	30	90.60	79.96	46.44	87.14	0.93	6.75	9.92	55
KER	41.07	4	3	96.97	27	25	72.38	96.65	76.89	79.40	0.96	1.80	7.66	58
MP	83.91	13	8	60.09	38	44	76.88	88.20	26.43	113.48	0.89	5.25	7.77	54
MAH	71.40	7	7	87.95	28	33	81.83	84.70	53.01	91.32	0.90	6.14	12.30	73
ORS	93.69	12	7	89.74	33	28	22.39	83.25	27.97	72.84	0.89	21.02	8.71	43
PUN	89.87	7	5	93.27	32	26	96.88	97.98	80.88	69.18	0.85	2.30	8.53	65
RAJ	76.37	13	9	86.00	31	28	91.13	82.63	41.30	95.61	0.77	13.67	8.77	44
TN	67.01	8	5	95.40	27	25	54.17	100.00	60.15	114.08	0.94	1.54	10.91	66
UP	76.28	6	3	75.25	53	46	96.14	97.72	78.20	80.04	0.93	12.33	7.03	52
WB	78.29	7	2	71.02	51	54	58.30	78.37	31.47	92.43	0.98	9.44	8.21	58

Source: NUEPA (2009)

Table 19 also shows the values of the indicators used for analyzing the state of educational attainment.[3] From the table, we observe that, TN and MP show very good performance in terms of GER while HAR and PUN show poor performance. We have also tried to take a look at gender parity in enrolment. In terms of GPI, ASM and WB are on the top while BIH and RAJ show relatively poor performance. Here in addition to the primary level, we have also tried to observe progression to higher education (in terms of W14 and W15). We find that GER in higher education is highest for MAH followed by TN and HAR. In fact, MAH and TN have high values of GER both at the elementary level as well as at the higher level. However, when we look at the proportion of literates with qualifications "graduate and above", we get a somewhat mixed picture. MAH still has the highest value (in terms of W15) but TN does not show equally good performance. Many states show better performance than TN in terms of W15. This pattern may be the fallout of better spread of the market for unskilled labour in TN compared to its competing rival states (in terms of educational attainment).[4]

We now try to arrive at an overall picture by reconstructing HII, HAI, EII and EAI using the indicators shown in Table 17. The values of the indices and the corresponding ranks of the states are shown in Table 20.

Table 20: Infrastructure and Attainment Indices, 2006

	HII		HAI		EII		EAI	
	Value	Rank	Value	Rank	Value	Rank	Value	Rank
AP	0.415	7	0.376	10	0.650	8	0.570	6
ASM	0.255	10	0.258	15	0.475	13	0.456	9
BIH	0.082	15	0.305	13	0.331	15	0.197	15
GUJ	0.521	6	0.456	7	0.719	5	0.529	7
HAR	0.227	11	0.426	8	0.720	4	0.650	3
KAR	0.570	4	0.515	5	0.738	3	0.678	2
KER	0.774	2	0.800	1	0.611	11	0.640	4
MP	0.165	12	0.289	14	0.631	9	0.441	11
MAH	0.534	5	0.598	3	0.671	7	0.825	1
ORS	0.404	8	0.324	11	0.626	10	0.435	12
PUN	0.776	1	0.611	2	0.790	1	0.442	10
RAJ	0.137	13	0.406	9	0.754	2	0.338	13
TN	0.695	3	0.557	4	0.684	6	0.630	5
UP	0.111	14	0.319	12	0.594	12	0.315	14
WB	0.335	9	0.472	6	0.390	14	0.520	8

Source: Calculated on the basis of secondary data (data sources shown below tables 18 & 19)

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[3] The values of W10, W11 and W13 have been taken from NUEPA (2009) and pertain to the year 2006-07 (except for W13 whose value is for the year 2005-06). The value of W14 has bee taken from the "Educational Data Bank for Higher Education" and is for the year 2002-03. The value of W15 has been taken from NSSO (2004-05).

[4] Prabhu (2001) has made a comparison of the social sector development in two states of

Table 21: Correlation between Infrastructure and Attainment

	HII	HAI	EII	EAI
HII	1.000	0.839*	0.450	0.617*
HAI		1.000	0.369	0.613*
EII			1.000	0.417
EAI				1.000

Source: Estimated on the basis of Table 20
*Correlation is significant at 0.05 level (2-tailed)

Table 21 presents the correlations between the composite indices for the year 2006. We observe that HII is strongly associated with both HAI and EAI and, in fact, the relation has become stronger in the post-reform period. The correlation between EAI and HAI is also quite high and statistically significant. However, no such association is noted between EII and EAI or HAI. So, creation of health infrastructure helps to improve not only that of health sector but that of education sector as well though the converse is not true.

V: Conclusion

The above analysis reveals that education and health are two crucial sectors that can be of great strategic importance in the process of social development of a region. Our study finds that although most states have improved their performance in the education and health sectors during the period 1981-2001, there is still a long way to go. Moreover, health attainment levels have gone down in many states during the post-reform period which is a major area of concern. This feature assumes greater significance in view of the fact that in improving the overall quality of life of the people in a poor country like India, the health sector seems to play a more fundamental role compared to the education sector. We find a high positive correlation not only between health infrastructure and health attainment, but also between health infrastructure and educational attainment. On the other hand, we not only observe a relatively weaker association between educational infrastructure and educational attainment, the association between educational infrastructure and health attainment is also very weak. Hence, in case of the health sector, both the

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India, viz., MAH and TN in the pre- and post-reform periods. The study finds that in the post-reform period, in both states, share of agriculture in NSDP has declined. But, in TN, the share of manufacturing has remained more or less stable whereas in MAH that share has also gone down substantially. Consequently, the growth in service sector was more spectacular in MAH compared to TN. The study also finds that although rural and urban employment in both states experienced a spread of informalization, casualization and feminization, TN had a larger pool of casual labourers. This fact may have its corresponding implication for the demand for better human capital in the job market resulting in demand for higher educational attainment.

direct and indirect effects are stronger compared to the education sector. In addition, it is now believed that development of the health sector is crucial for alleviating poverty (Misra, Chatterjee and Rao, 2003). This calls for special attention and a greater share of resources for the health sector.

However, if we look at allocations for the health sector, we get a very bleak picture. Prabhu and Sudarshan (2002) find that public expenditure on health constitutes only 1.8% of GDP when several official committees in India (Kothari Commission 1966, Ramamoorthy Committee 1991 and ICSSR-ICMR Report 1981) have recommended that the expenditure on education and health be at least 6% of GDP for each of these sectors. Moreover, even these levels have been threatened since the initiation of the economic reforms in India in 1991.

Analyzing levels of health expenditure in the major states of India, Shariff and Gumber (2002) find that while Kerala spent 9.5% of its Net State Domestic Product (NSDP) on health in 1993, in the relatively prosperous states of Punjab, Haryana and Maharashtra this share was around 3%. Moreover, in nine states, the percentage share of government health expenditure in NSDP ranged from 2% to 5%. It is also observed that a major part of the expenditure on health is out of the household's pocket. Even in Kerala, which has the highest level of public expenditure on health among the major states, household's share in total health expenditure is as high as 81.3%.

The "National Human Development Report, 2001" (Planning Commission, 2002) finds that the states spent, on an average, 5.78% of the total public expenditure on health in 1998-99. The report also shows that only three states (AP, KAR & TN) could increase their allocations for the health sector during the period 1980-81 to 1998-99. In fact, share of social sector allocations has gone down in many states during the post-reform period. The fiscal stringency experienced by most states during the post-reform period has forced them to cut back public expenditures; and social sectors have received the greatest blow of this cut because expenditures on these sectors do not bring immediate returns. This remains a major area of concern and efforts need to be made to increase resource allocations for this sector.

However, it should be remembered that resources, if not properly utilized, cannot be expected to influence attainments favourably. In fact, when some social targets are intended, not only the allocation of funds but transparency in institutional specification becomes important. Since social sectors include programmes involving people at the grass-root level, decentralization seems to be the right institutional choice in this context. However, serious policy considerations center around the specification of the appropriate organization for decentralization in order to ensure accountability.

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Appendix I

Data Sources : Secondary data for analysis of the education sector was collected from the following sources. Data on *Adult Literacy Rate* was collected from the relevant Census reports while that on *Gross Enrolment Ratio* (Classes I-VIII) was collected from different issues of the "Economic Survey", Govt. of India. It is to be noted that the "Economic Survey" gives data on Gross Enrolment Ratio separately for "Class I-V" and "Class VI-VIII" from which we have computed combined Gross Enrolment Ratio as the simple average of the enrolment ratios for the primary and secondary stages. Data on *Gross Dropout Rate* was gathered from the corresponding Annual Reports of the Ministry of Human Resource Development. Regarding the educational infrastructure indicators, data on *Number of Recognized Educational Institutions and Number of Teachers in Recognized Educational Institutions* has been taken from different issues of the "Statistical Abstract, India" published by the Central Statistical Organization, Government of India while that on *Pupil-Teacher Ratio* (PTR) in primary, upper primary, secondary and senior secondary stages was gathered from different issues of "Selected Educational Statistics" published by the Ministry of Human Resource Development. Data on the additional indicators given in Col.3 of Table 1 was taken from the report published by the National University of Educational Planning and Administration (NUEPA) in 2009.

Data on *Life Expectancy at Birth and Infant Mortality Rate* has been collected from different issues of "Family Welfare Programme in India Year Book" published by the Ministry of Health and Family Welfare, Government of India. *Infant Survival Rate* has then been computed as "thousand minus *Infant Mortality Rate*". Data on the health infrastructure indicators has been taken from different issues of the "Statistical Abstract, India" and "Health Information of India" (published by the Ministry of Health and Family Welfare, Government of India). Data on the additional indicators given in Col.3 of Table 4 was taken from the third National Family Health Survey, India by the Ministry of Health and Family Welfare and Report No.507 of National Sample Survey Organization (NSSO).

We have expressed the education and health infrastructure indicators in terms of "per 100,000 population". In case of *Number of Recognized Educational Institutions and Number of Teachers in Recognized Educational Institutions*, the relevant age-group of the population has been considered to be 5-24 years as this is the age-group to which students generally belong. For this purpose, population data has been collected from "Statistical Abstract, India".

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Source Separation and Organic Waste Disposal : Policy options for Household Waste Management in Developing Countries⊥

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Abstract

Bio-degradable waste accounts for major portion of municipal garbage in developing countries. A major focus of waste management policies in these areas is to arrange for alternative disposal option that would convert the organic waste into usable products. Composting is one such option but it's applicability in municipal waste management practices have eluded the policy makers in low and middle income areas for long. One of the major reasons for this failure is inadequate regulatory attempts to ensure disposal of pre-sorted organic waste from the source of generation. Using a simple general equilibrium model this paper attempts to formalize incentive schemes that are required to induce source segregation at the household level and adoption of compost production as a garbage disposal service along with landfill in the setting of a developing urban area. For effective source separation either a specific tax on mixed waste disposal or a deposit refund system is needed accompanied by a subsidy on compost production in both the cases. Comparative static results indicate that subsidizing compost producers with more productive resources could actually be efficiency enhancing leading to a strengthening of the case for competitive service provision of public utilities in developing countries.

Keywords : Municipal Solid Waste, Source-separation, Pigouvian tax, Deposit-refund.
JEL Classification : H23, Q53, Q58

1. Introduction

Urban planning in developed countries of late is largely influenced by the concept of sustainable cities. The concern over sustainable use of urban resources has become necessary as there has been a vast change in lifestyle of the people in the high income countries through globalization induced market integration. One immediate impact that has a large bearing upon urban environment is the phenomenon of rising product obsolescence.[1] This adds to the already rising

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Key Words: Municipal Solid Waste, Source-separation, Pigouvian tax, Deposit- refund.
JEL Classification. H23, Q53, Q58

[1] This concept derives from Packard (1960) who identifies three types of product obsolescence i) functional obsolescence: when the new products can perform the function of the older products with greater ease ii) fashion obsolescence: when consumers prefer new products for reasons of taste and iii) durability obsolescence: when the product can no longer perform its function because of wear and tear.

volume of waste from urbanization and puts immediate pressure on the landfill sites. From the planners perspective the way out of this is to substitute landfill at least partly by alternative disposal methods like recycling, composting and incineration. To promote these alternative methods of disposal the social cost of waste dumping should be internalized through various legislations and market based instruments.

The general aim of the policy instruments so far were to make the relative price of landfill dearer thereby increasing the adoption of other disposal options like recycling, composting and given the higher calorific value of high income country's waste, incineration at large. Of course at the point of generation households were required to pay the user fee for the amount of trash they generated and return for recycling efforts were destined to bring about optimal level of waste disposal that the local bodies or its delegated waste management companies must handle. Product Taxes were also introduced to make packaging more amenable to recycling and sanctions were imposed on the type of products that has high cost of recycling like Polyethylene Terepthalate (PET) variety of plastics. High levels of awareness among households in developed countries ensured quick adoption of these regulations and the market for recycling, though regulated, is actively functioning in these high income countries. On the disposal side stricter sanctions and quality controls have resulted in various strategies on the part of the industry and local government where the former has developed institutionalized collection systems of its own products and the latter have innovated public collection schemes like Kerb Side Recycling, Drop Off Centers and Material Recovery Facilities to achieve the targets set by the federal governments. Another interesting recent development is the effort to integrate environmental impacts of municipal waste dumping with global pollution like methane emission that is a potential Green House Gas (GHG) through tradable permit like instruments called Certified Emission Reduction (CER).

In sharp contrast with this technologically upgraded and market oriented system of waste management the condition in developing nations are far from optimal. The collection and disposal of waste up till now has been mostly executed by revenue starved local governments and any exchange of recyclable items whatsoever takes place between households and the informal sectors consisting of refuse collectors and itinerant buyers. In most parts of developing countries the post consumption waste is rich in organic contents and often constitutes the major portion of the total urban refuse. The informal sector takes away the recyclable portion of the waste and so the biodegradable part is dumped in landfills along with other categories of waste that putrefies and contributes to methane generation. Thus, a major policy challenge for urban planners in developing countries is to arrange for some end use of biodegradable waste and to this extent biological process like composting and biomethanation suggests themselves. These techniques convert the otherwise value less organic substance into commodity like organic manure that can be sold in the market. Several barriers pose threats to the actual realization of these outcomes along the waste management chain in cities of developing countries.

Uncontaminated waste input is essential for compost production in line with acceptable standards. However, for households in less developed areas separating waste at source is relatively dearer option than mixed waste disposal that he is habituated with. Hence, absent incentives it would be difficult to attain the desired level of source segregated waste at the point of generation. On the other hand even if source separated waste is available the socially desired level of compost production may not take place. Repeated failure of waste to energy as well as organic manure producing projects to operate on a long term basis in several developing countries bears testimony to this fact.[2] Private net benefit from these kinds of projects has been typically low as the market for processed waste like compost is still underdeveloped in low income areas. Unless the social value of compost production is internalized in the production process long run sustainability of such alternative disposal practices would be hard to guarantee.

This paper attempts to formalize such incentive schemes that need to be applied at various stages of waste management sectors in the setting of a less developed area. In the next section (Section 2) the theoretical literature of economic instruments for household waste management is reviewed briefly. The analytical model of policy alternatives is delineated in Section 3. Section 4 outlines the comparative static results of the model followed by the conclusion in Section 5.

2. Economics of Source Separation: A Brief Review of Literature

Given the extent of recycling activities, the choice between conventional or mixed waste disposal and source separation depends on the relative resource cost of the two activities. From the stand point of households mixed waste disposal is associated with lower resource cost (for instance time cost, storage cost etc.) than separating waste at source. Thus in absence of any volume or weight based fee, private behaviour will always lead to mixed disposal other than source separation that is induced by the re-use and recycling motives.

In itself source separated waste is an intermediate good for producing public good like compost production. A higher degree of segregation provides the individual both environmental and health benefits in terms of displaced landfills and higher compost production. To see this, note that given the price of synthetic fertilizer, the demand curve facing the compost producer is fairly elastic. Assume now that the cost of producing the compost is increasing in the amount of contrary materials present in the waste stream. This implies that the supply curve of compost output is positively sloped (S_0S_0). If wastes are source-separated, more compost will be supplied at given price and the supply curve shifts to the right (S_1S_1). As a result compost production increases from w_c^0 to w_c^1 (see figure 1).

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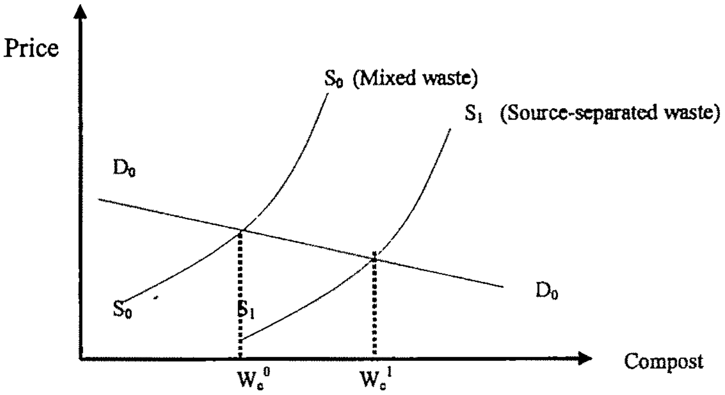
[2] Roussee (2006) for instance, describes how the Jam Chakro landfill originally designed to be a sanitary landfill ultimately reverted back into open dumps. Closure of bio-methanation project in Ahmedabadh, India also took place due to lack of adequately sorted waste Joseph (2007).

Figure 1: Source Separation and Compost Production



Policy initiatives to bring about source separation must have one thing in common with that designed to enhance recycling. In both cases intervention should be such as to increase the relative price of mixed waste disposal. Assuming that the household chooses between only two alternatives the increase in relative price can be obtained either by taxing households or by subsidizing recycling by pure substitution effect. Charges on waste disposal may either take the form of volume or weight based per unit tax or advanced disposal fees both falling in the class of "discard relevant instruments". When set at marginal social cost waste dumping, Fullerton and Kinnaman (1995) shows that unit pricing can gear the waste disposal towards socially optimal level. The implied negative price elasticity of demand for garbage disposal is supported empirically by Wertz (1975), Jenkins (1993), Seguino et. al. (1995), Kinnaman and Fullerton (1997) and Podolosky and Spiegel (1998)[3]. Advance Disposal Fee (ADF), on the other hand, is best applicable in case of non-recyclable items for ensuring their proper disposal (Calcott and Walls, 2000). The imposition of ADF in case of beverage containers in Florida during 1993 to 1995 could be a case in point (Ackerman, 1997). The products that met the recycling standard of 50 percent was exempted from ADF and within few years of its implementation only those class of containers remained within its ambit that could not meet the recycling standard perhaps due to prohibitive technological cost.

Correcting for relative prices at the end of the source of waste generation is only one part of the story. Making the households realize the actual social cost of his waste disposal and generation activities and thereby guiding the choice towards a socially optimal level of waste disposal and recycling may ultimately bear no fruit if appropriate disposal facilities are not arranged for. In effect there are two distinct classes of waste disposal providers in developed countries: municipal authorities and market based recycling consortiums or individual agencies. However, imposition of unit pricing often give rise to the problem of illegal dumping and here to the extent an additional cost of enforcement is required to ensure proper disposal the problem of second best comes into action. Though the first best in presence of illegal dumping is still attainable by introducing a charge on consumption and a subsidy on recycling its administrative cost is prohibitively high when all items in household's consumption basket are to covered. In such a situation Choe and Fraser (1999) demonstrates that a positive waste collection charge on households, monitoring of illegal disposal and a positive waste collection charge on the firm producing consumables would lead to the second best outcome. Shinkuma (2003) shows that in presence of transaction cost a high positive price of recyclables render unit pricing together with ADF the second best policy option, and producer take back would be the required policy if price of recyclable is negative. Further if the marginal transaction cost is low the regardless of the sign of the price of recyclables deposit refund would be the second best choice.

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[3] On a dissenting note Reschovsky and Stone (1994) finds that price of garbage has no significant impact on household recycling.

The "downstream discard relevant instrument in the literature did not focus adequate attention on the potentials of source separation in the context of biodegradable waste. Here emphasis has generally been laid on the encouragement of re-use and recycling. This chapter wants to make a distinction between biodegradable and non-biodegradable waste and for the former composting is targeted as the relevant management option.

3. Theoretical model of Source Separation

The objective of the regulator then is to enlarge the choice set of feasible disposal options open to the households by including segregation of waste at source. In the absence of any interventions, the waste generated in a household is either recycled and sold to the itinerant buyers or disposed as mixed garbage. Since garbage is a public bad and the municipal authority incurs cost to manage it, so the social cost of garbage disposed is much higher than its private cost. This leads to excess waste generation induced by socially excess consumption and, therefore, the regulator may impose tax on the generation of mixed garbage to bring back the social optimum. If the regulator can design appropriate policy instruments then the households may be induced to transform part of this garbage into source separated waste. The biodegradable part of the separated waste is used for composting and the local body landfills the remaining portion of refuse. So, the cost incurred in source separation can be perceived as an abatement cost. Here, the policy should match this cost in the margin through the promised incentive. Intuitively this suggests that the tax on source-separated garbage should be less than that on the mixed garbage to induce household to undertake the separation cost.

3.1 The Basic Model

To formalize the foregoing discussion, assume that there are n identical households in a locality. Households consume a composite commodity, c, and generates post-consumption waste g, such that

$$g = g(c), \text{ and } g' > 0 \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The regulator has to spend some resource to landfill this waste. Assume that the per-unit resource requirement for such disposal activity is constant, say γ. However, the resource cost of landfill activities can be reduced if the household sends less waste for dumping and this can be achieved if the biodegradable and inert waste is separated at source. Assume that θ fraction of g consists of biodegradable waste, say b. More formally, we denote the amount of organic waste by

$$b = \theta g \text{ where } 0 < \theta < 1 \ldots\ldots\ldots (1)$$

Suppose, the household requires k_s, amount of resource to separate the biodegradable part of the garbage, say, b^s[4]. The source-separation activity can be characterized by the function,

$$b^s = l(k_s), l' > 0, l'' < 0 \ldots (3)$$

Inverting the above function, we get,

$$k_s = m(b^s), \text{ where } m' > 0,\ m'' > 0 \ldots. (4)$$

It is also evident that $m'(0) = 0$ which follows from the equivalent restriction that $l'(k_s) \to +\infty$ as $k_s \to 0$.

The remaining portion of the garbage i.e. $(g - b^s)$ is land filled and creates a disutility to the household in terms of health and aesthetic costs. Also we assume that it may not be efficient to source separate all organic waste so that

$$0 \le b^s \le b \Rightarrow 0 \le b^s \le \theta g \ldots (5)$$

The source-separated waste b^s is procured by compost producing firms without incurring any cost. They convert b^s to organic manure say, z, by the fixed-coefficient production function.[5, 6]

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[4] In practice, the households in cities of developing countries also separate recyclables from the regular waste. However, the market for recyclables clear and we do not consider the environmental impacts of recycling process. Instead, we focus on the disposal choice between source separation and mixed waste disposal. Unlike recycling source separation is a non-market activity in the sense that households do not receive any direct payment for source-separated waste.

[5] Thus in absence of source separation i.e. for $b^s = 0$ compost production does not take place implying that $z = 0$.

[6] We assume that no additional resource is required to dispose the byproducts of compost production and there is no disutility from the byproducts of the compost production.

$$z=\min\left\{\alpha b^{s},\beta k_{z}\right\} \Rightarrow z=\alpha b^{s}=\beta k_{z} \text{ .... (6)}$$

In this case, b^s is a given to the firm and they only choose the other input k_z such that the input ratio is $\frac{\alpha}{\beta}$. The term $\frac{\alpha}{\beta}$ can be interpreted as constant per unit cost of compost production. Compost production provides considerable environmental benefit like improving the retention of water in the soil and partially replacing the usage of chemical fertilizers. Thus, z is a source of positive externality to the household in our model. Accordingly, the utility function of the households can be written as

$$u[c,G,Z]; \text{ where } u_c>0, u_G\leq 0, \text{ and } u_Z\geq 0 \text{........(7)}$$

Here we define $G=n\left(g-b^{s}\right), Z=nz.$

The producers of garbage disposal service, uses resources k_g, such that

$$k_g=\gamma(g-b^{s}) \text{ .... (8)}$$

where γ is the unit cost of mixed waste disposal.

The firm, that produces the composite commodity c, uses the organic manure z, and another input k_c in the production process and the production function is assumed to exhibit constant returns to scale

$$c=f(k_c,z); f_z>0, f_{k_c}>0 \text{... (9)}$$

As z and k_c are considered to be substitutes in the production activity, k_c can be interpreted as the resource spent in using synthetic fertilizer (say, urea).

The total resource endowment for the community is denoted as k. This resource is owned in equal shares by the n identical individuals, i.e. $\frac{K}{n}=\bar{k} \Rightarrow n\bar{k}=n\left(k_g+k_s+k_z+k_c\right)$. This means that the aggregate resource requirement for the economy can be written as

$$\bar{k}=k_c+k_g+k_z+k_s \text{ .... (10)}$$

The social planner maximizes utility of the representative household in (7) subject to the production constraints (1), (4), (5) (6), (8) and (9) and the aggregate resource constraint (10).

Thus the necessary conditions for Pareto optimum is obtained by maximizing the appropriate Lagrangian

$$L^s = U\left[c,G,Z\right]+\delta\left[f\left\{z,\bar{k}-m\left(\frac{z}{\alpha}\right)-\gamma\left(g-\frac{z}{\alpha}\right)-\frac{z}{\beta}\right\}-c\right]+\mu\left[\theta g(c)-b^s\right]$$

with respect to c and $\dot{z}$ respectively.

The first order conditions are

$$U_c+nU_G g'+\delta\left[-f_{k_c}\gamma g'-1\right]+\mu\left[\theta g'\right]=0 \quad \ldots \text{(11a)}$$

Due to the non-negativity restrictions on z, we apply the Kuhn-Tucker conditions

$$-n\frac{U_G}{\alpha}+nU_z+\delta\left[-f_{k_c}\frac{m'}{\alpha}+f_{k_c}\frac{\gamma}{\alpha}-\frac{f_{k_c}}{\beta}+f_z\right]+\mu\left[-\frac{1}{\alpha}\right]\leq 0$$

$$z\left[-nU_G+\alpha nU_Z+\delta\left\{\alpha f_z-f_{k_c}m'+\gamma f_{k_c}-f_{k_c}\frac{\alpha}{\beta}\right\}+\mu[-1]\right]=0 \quad \ldots \text{(11 b)}$$

and $z \geq 0$, where δ is social marginal utility of income and μ is the shadow price of source separable organic waste.

If source separation is indeed desirable from society's point of view, then at the optimum z must be strictly positive. In fact, if the unit cost of mixed waste disposal exceeds the cost of composting from the point of view of the society, z = 0 can never be Pareto optimal.

To see this note that $z = 0$ implies that source separation has not taken place (i.e. $b^s = 0$). Since $c > 0$, we have $\theta g(c) > b^s$ and hence $\mu = 0$[7].

At $z = 0$ the first order condition in (11b) reduces to

$$-nU_G+nU_Z+\delta\left[\alpha f_z-f_{k_c}m'(0)+\gamma f_{k_c}-f_{k_c}\frac{\alpha}{\beta}\right].$$

Further, if it is assumed that the unit cost of mixed waste dumping is higher than that of compost production from the point of view of the society, then $\left(\gamma-\frac{\alpha}{\beta}\right) > 0$.

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[7] The Kuhn -Tucker condition for μ reads $\frac{\partial L^S}{\partial \mu}\geq 0$ and $\mu\left[\theta g(c)-b^s\right]=0$. For $\theta g(c)>b^S$, $\frac{\partial L^S}{\partial \mu}>0$ and so $\mu=0$.

Thus, the term $-f_{kc}m'(0)+\alpha f_z+f_{kc}\left(\gamma-\frac{\alpha}{\beta}\right)$ is positive; this, together with the given sign restrictions on U_G and U_Z implies that evaluated at z = 0, $\frac{\partial L^s}{\partial z}>0$. We have thus contradicted a basic requirement at the optimum and, hence, z = 0 cannot be optimal after all[8].

In the private market, the individual maximizes utility in (7) subject to the budget constraint.[9]

$$p_k\left(k_c+k_g+k_z\right)=p_k(\bar{k}-k_s)=p_k\left(\bar{k}-m\left(b^s\right)\right)=c+\left(p_g+t_g\right)\left(g-b^s\right)$$

and $b^s \leq \theta g$. The left hand side of the constraint gives the income of the consumer where p_k is the per unit price of resources. Assume that c is the numeraire good, p_g is the per unit price of garbage disposal service and t_g is the tax rate on garbage disposal. If households consider Z as given and ignore its own contribution to the land filled waste the first order conditions are

$$U_c+\lambda\left[-\left(p_g+t_g\right)g'-1\right]+\psi\left[\theta g'\right]=0 \text{ ... (12a)}$$

$$\lambda\left[-p_k m'+\left(p_g+t_g\right)\right]+\psi[-1]\leq 0$$

$$b^s\left[\lambda\left[-p_k m'+\left(p_g+t_g\right)\right]+\psi[-1]\right]=0 \text{ ... (12b)}$$

where λ is the private marginal utility of income. In absence of any incentive, say if garbage is collected without any charge i.e. $p_g + t_g = 0$, surely $b^s = 0$[10] : source separation at the household level is not practiced.

In the product market compost producing firms practice average cost pricing[11] such that

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[8] These conditions also ensure that the net benefit from source separation exceeds the shadow price of source separation at a zero level of source separation activity.

[9] We assume that the households have a lump sum share in the profits of the firms. Thus, the budget constraint also includes a constant term that disappears in the first order conditions for market out come.

[10] $\theta g(c)>b^s, \frac{\partial L^s}{\partial \mu}>0$ and so $\mu=0$. the first order condition in (12 b) is strictly negative so b^s is equal to zero.

[11] Most waste processing plants in less developed areas operates on the basis of public-private partnership. For instance, in case of Kolkata a metro city in India a company called Eastern Organics Pvt. Ltd carried out the project of producing manure out of municipal waste. In many ways, the operative firm resembled a natural monopoly providing local utility service (for e.g. incurring huge fixed cost for setting up its facility). At the same time, it was regulated by government guidelines and had a revenue sharing obligation with the local government. Thus for a regulated natural monopoly setting price equal to average cost would have been the next best alternative to marginal cost pricing.

$$p_z = AC_z = \frac{p_k k_z}{z} = \frac{p_k k_z}{\beta k_z} = \frac{p_k}{\beta} \quad \text{... (12a)}$$

where p_z is the per unit price of organic manure. Profit maximization in the market for c implies

$$\pi^c = f(z, k_c) - (p_z + t_z)z - p_k k_c$$

where t_z is the per unit tax on z

$$\Rightarrow \pi_z^c = f_z - (p_z + t_z) = 0 \quad \text{...... (14)}$$
$$\Rightarrow f_z - t_z = p_z$$

$$\text{and} \quad \begin{aligned} &\pi_{k_c}^c = f_{k_c} - p_k = 0 \\ &\Rightarrow f_{k_c} = p_k \end{aligned} \quad \text{..... (15)}$$

Using (15) and (13), (14) can be written as

$$\beta(f_z - t_z) = f_{k_c}$$

$$\beta f_z - f_{k_c} = \beta t_z \quad \text{.................... (16)}$$

Similarly, assume that producers of garbage disposal service earns zero profit[12] so that $p_g(g - b) - p_k k_g = 0$. This implies, $p_g \frac{k_g}{\gamma} = p_k k_g$ and so $p_g = \gamma p_k$. Thus, we can substitute the marginal products in place of prices in the first order conditions for decentralized market equilibrium to make it comparable with the necessary conditions for Pareto Optimal outcome.

3.2 Policy Options

Clearly with no government intervention i.e., with $t_g = t_z = 0$, equation (12 a) and (12 b) does not match the Pareto Optimum conditions. However, for $\delta = \lambda$ and $\mu = \lambda$ equation (12 a) matches (11 a) only if $t_g^* = -\frac{nU_G}{\lambda} > 0 \,|$ i.e., the optimum tax rate on garbage disposal is positive. At the same time, given t^*_g, (12 b) matches (11 b) only if $t_z^* = -\frac{nU_z}{\lambda} > 0$.

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[12] Since the garbage disposal activity is produced competitively at constant cost no profit is involved in its production. Though empirical evidence for constant returns to scale in garbage disposal services is available for other communities (see for instance Stevens (1978)) we adopt it in case of Kolkata for expositional convenience.

Thus, if households are taxed on garbage disposal, the relative price of mixed waste disposal increases and household chooses the relatively cheaper disposal option namely source-separation. However, the supply of source-separated waste may not match the demand for organic manure. This is because the per unit price p_z fails to reflect the marginal benefit of the production of organic manure in terms environmental gains from sustainable agricultural practice. Thus, there must be a subsidy on the usage of organic manure. Given p_k, the producer of commodity c substitutes more z for k_c and the first best outcome is achieved. The result confirms the long-standing demand for a subsidy on organic manure by compost producers. However, to achieve the first best outcome the subsidy must be coupled with a per unit tax on garbage disposal that reflects the net aggregate externality from mixed waste disposal.

In practice, the local bodies in developing countries do not collect any user charge from its residents. Charges for waste disposal services are mostly collected as flat fees that fail to affect the household's disposal behaviour at the margin. However, any alternative policy instrument that makes mixed waste disposal dearer to source-separation can guarantee socially optimal disposal behaviour. For instance, a per unit subsidy on source-separated waste would also raise the relative price of mixed waste disposal. Unfortunately, this also implies that there is an implicit subsidy on consumption as the cost of waste disposal declines. Hence, there is socially excess consumption and more total waste resulting in higher aggregate net externality. Thus, to maintain proper relative price in general equilibrium consumption must be taxed. To derive this multiple policy instruments formally, rewrite the consumer's budget constraint as

$$p_k\left(\bar{k} - m\left(b^s\right)\right) = \left(1 + t_c\right)c + p_g\left(g - b^s\right) - t_b b^s$$

where t_c is the per unit tax on consumption. Again for $\delta = \lambda$ and $\mu = \psi|$, the decentralized market outcome will match the social optimum for the following tax rates

$$t_c^* = -\frac{nU_G g'}{\lambda} > 0$$

and

$$t_z^* + t_b^* = \frac{nU_G}{\lambda} - \frac{nU_Z}{\lambda} < 0$$

This is essentially a deposit refund system with deposits collected on consumption and refunded on source-separated waste. However, this time it is not necessary to subsidise the compost output directly -a subsidy on source-separated waste could bring about the optimal level of compost production (i.e. with $t_b^* = \frac{nU_G}{\lambda} - \frac{nU_Z}{\lambda} < 0$ and $t^*_z\rfloor = 0$). Alternatively, instead of subdising innumerable households the regulator may decide to subsidise fewer compost firms. In both cases, the first best level of outcome is achieved.

4. Comparative Static

The model so far has considered a representative waste management system defined by the parameters and accordingly solved for the policy instruments. However, the stakeholders in the waste management system are likely to be different across time and space and thus the parameters are likely to change. For instance, the relatively higher biodegradable component of less developed areas may actually decrease over time due to growing preference for packaged food.[13] Similarly, the efficiency of the compost producers may actually vary given the supply of source separated waste. Thus, one could expect θ and β to vary both temporally as well as spatially.

Intuitively an increase in θ would lead to more total waste given the extent of source separation activities and so t_g^* the Pigouvian tax rate that is equal to the marginal social cost of waste disposal must increase. On the other hand with the increase in β the per unit cost of compost production must fall relative to the social cost of mixed waste disposal and so from the point of view of the social planner more compost production should be encouraged. Hence, the per unit subsidy on compost production t^*_z must increase.

To see this formally totally differentiate the expression of t_g^* to get

$$dt_g^* = \frac{n^2 U_{GG} b}{\theta^2 \lambda} d\theta - \frac{n^2 U_{GG}}{\lambda} dz$$

As, $\frac{dz}{d\theta} = 0$ we get $\frac{dt_g^*}{d\theta} > 0$ as $U_{GG} > 0\rfloor$ following the usual second order regularity conditions.

Next, totally differentiating

$\beta f_z - f_{kc} = \beta t_z$ in (16) we have

$$f_{zz} dz + \frac{f_{kc}}{\beta_z} d\beta + \frac{f^r_{kc}}{\beta} df_{kb} = dt_z^*$$

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[13] A World Bank study (1999) predicts that by 2025 waste stream from developing countries would be more voluminous compared to developed countries owing to the increase in paper and plastic component in municipal waste.

Since, $\frac{dz}{d\beta}=\frac{df_{kc}}{d\beta}=0$ we get $\frac{dt_z^*}{d\beta}=\frac{f_{kc}}{\beta^2}>0$.

Thus, our intuition is confirmed.

5. Concluding Observations

This paper has discussed the possible policy options that are needed to induce segregation of waste at the household level in the context of less developed areas. For effective source separation either a per -unit tax on mixed waste disposal or a deposit refund system is required accompanied by a subsidy on compost production in both the cases. The comparative static results reports that the Pigouvian tax ought to be directly related to the consumption patterns of the residents.[14] Secondly, subsidizing relatively more productive resource owner in compost production would enhance efficiency. As such, this result point towards the present situation of public-private partnership in provision of municipal services in urban areas of less developed countries. Most of these projects are operated by private waste managers with consultancy and administrative support from the government. To encourage private entrepreneurs the regulators often subsidize the cost of operating capital as well as land for siting of waste processing plants.[15]

However, choosing among the suggested policy alternatives is not an easy task: imposition of Pigouvian tax can lead to the problem of illegal dumping while subsidizing segregated waste collection may actually increase waste generation. Of course the income effect from subsidy can be countered by the 'deposit' tax on consumption but within the limited administrative capacity of the local government it may be difficult to implement it effectively. For one thing such taxes on consumption may not be applicable for commodity bundles purchased beyond the municipal jurisdiction. Hence, a more realistic approach would be to 'impose' a waste management charge on the household while subsidizing the collection of source segregated waste. In fact experiences from developed countries have shown that the extent of illegal dumping has been lower in areas where there is both per-unit taxes on waste collected as well as Kerb side recycling (UN-HABITAT,2009). Formalization of such second best schemes in the context of possibility of illegal dumping would be the future research agenda.

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[14] The consumption pattern may be determined by ethnicity as well as the relative price of cereals and non-cereal items. In India for instance, it has been estimated that there is a tendency to shift towards non-cereal food items even among low income groups owing to the high relative price of cereals (Ray, 2007).

[15] Ayalon et. al. (1999) describes subsidies given to recycling plants in Israel. For experiences in other developing countries see UN-HABITAT (2009).

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BOOK REVIEW

Monetary, Investment and Trade Issues in India, by Ramkishen S. Rajan, 2009, Oxford University Press, New Delhi.

The current volume under review provides an account of the policy challenges faced by the Indian policy-makers in view of the recent developments in the Indian economy. Generally, readers are familiar with books written by eminent policy-makers providing rationale for the policies adopted by the erstwhile policy regimes. Such books attract wide readership because generally people like to listen to the musings of mind of those policy-makers when they are no longer in a position of stewardship. However, it should not be overlooked that some of those books unveil the deep insight interwoven with economic decision-making. On the other hand, there are plenty of writings in professional journals and in edited volumes which are highly analytical in content but not accessible to the general reader. The author of the present volume has tried to maintain a balance between the above two. He has picked up issues which are relevant for contemporary discourse on Indian economics. He has presented the problem to the reader in the simple way at the beginning of each article. Then he introduced the econometric exercise to examine the veracity of his claims regarding the policy action. Obviously the latter parts of the articles are meant for well-trained economists and researchers. But it must be stressed that the readers will not miss much in terms of the grasp of the issues concerned if they skip the econometrics part.

In recent years there has been a feeling of complacency over the high growth phase of the Indian economy. This feeling was fuelled by the famous BRICK Report and growing interest among the overseas investors about India. However, this prosperity is not unmixed blessing. Apart from the real economic challenges that this prosperity has thrown to the public like widening inequality, deeper agrarian crisis and ever-rising prices of food and essential commodities the policy-makes have their shares of nightmares in the form of various policy dilemmas. The author has categorised these policy challenges under three broad heads – exchange rates and inflation, international reserves management and investment and trade. Therefore, it is obvious that the author's interest centres around the external economic policy making.

In the essay "How flexible is the Indian Rupee? " the author has tried to prove that Indian rupee is softly 'pegged' to US dollar. This is almost a truism in international finance circle these days that the countries practice what is called "managed float" – controlling the volatility in the exchange rate while leaving its level to the market forces. Since dollar is the hard currency most countries might take the movement of dollar into the consideration. Methodologically, the author has not considered the excess volatility phenomenon of exchange rate in the estimation procedure.

In the paper "Should India Adopt an Inflation Targeting Framework?" the author tried to convince the readers that Reserve bank of India has been following a kind of inflation targeting framework without being explicitly declaring it. However, it should be remembered that Taylor rule has been referring to a system where some policy rate is periodically announced. But this practice has not been set up in India. The author has used 91-days treasury bill rate for estimation of monetary policy rule for India. But treasury bill rate is not a policy rate.

The author has rightly pointed out that the pass-through effects of exchange rate movement on the consumer price index has been a gradual process in the Indian context. Though liberalization took off since 1991, India did not dismantle all the elements of administered pricing regime at one go. Perhaps this is most evident in the case of oil and petroleum prices.

The three essays on the international reserve management have addressed many important issues. But the important miss for this section might be the "impossible trinity". Maintaining a high international reserve without compromising growth and lower inflation was the challenge faced by policy-makers from the emerging market economies. This should have been highlighted.

The last section deals with issues some of which are normative and futuristic in nature. However, the essays on export structure of India and China and the outward investment by Indian corporates make an interesting reading.

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North-East India : a search for development

Growth and Human Development in North-East India by P. Nayak (Ed.), Oxford University Press, New Delhi, pp. xxxii + 349, price: Rs.750/-

It is more than two decades the conception of Human Development (HD) has received widespread acceptability across various disciplines of social science. Measurement of human development has also drawn (and still is continuing) renewed attention, since it's inception in 1990, primarily from the economists. India, in many senses, is a representative nation for meaningful application of human development, for both the dimensions of concept and measurement. The present title is a useful addition in that area.

Twenty-five chapters presented in this book are divided into three well designed sections. From the title it follows that two areas of research – growth and human development – are addressed simultaneously. Interrelationships between the two rightly come into automatically. Selection of the chapters rightly demonstrates that emphasis is on human development. All the three chapters of section one are devoted to theoretical developments in the literature of HD. They are very useful for post graduate and research training courses. Interested research students can make ample use of the materials discussed there since they do not presume familiarity with sophisticated techniques. Of all the sections this one deserves maximum number of benefiting readers.

Next importance of the book lies in the chapters covered in section three. Eleven of the fifteen chapters address issues of HD; three are concerned with growth; and finally one deals with the interaction between the two. All the chapters in this section are targeting empirical evaluations of the concerned issues as prevalent in the North-East India. These evaluations are in the form of either across the states of North-East India or for separate states. First four chapters of this section are of the first variety. There are nine chapters to do with states of North-East India separately. Standard expectation from chapters alike these is that they would represent results of analysis across districts of the concerned states. It is unfortunate that this has been belied for four chapters. What is more surprising for this section as a whole is that no one has compared their results with the ones prevalent in a relevant publication (NCAER, 2009). Only chapter 23 utilises this reference. As far as empirical analysis is concerned, most of them have done justice to the issues of HD, either separately or together. The chapter on Arunachal Pradesh is exceptionally rich in analysis but out of focus of HD. How successful roles of Self-Help Groups in the area of microfinance could lead to improvement in HD has not been dealt with in chapter 17. Analysis of reasonable extent is missing in some chapters (for example, chapters 21 and 22) of this section.

There are altogether seven chapters in section two. Four chapters are worthy of mention. These are chapters 4, 5, 9 and 10. The two-way movements: economic development to human development and the reverse have been well captured in chapter 4. Empirical results would have added elegance. The result – non-income components of HDI are influenced by income component – has been explicitly established in chapter 5. Many might be pleased with this result. Chapter 9 has addressed adequately the missing link between economic development and human development. But how to make good governance a prevalent practice is not suggested. Chapter 10 has highlighted the fact, often forgotten, that market operations are well facilitated when human development level is high. But it has least interest to make human development improve. Thus state can least afford to ignore responsibility of bringing improvement in human development. Chapters 6 and 7 discuss issues those are indirectly related to HD. Any serious reader would wonder inclusion of chapter 8 in this book.

Altogether there are five chapters from the editor, either solo or with co-authors. Chapters 12 and 25 have failed to do justice to the standard set by the other three.

Since inception of HDI, two directions of research are quite prevalent. One category highlights limitations in the concepts and measurements of HDI and their solutions. The other category indicates directions in the quality of life beyond human development, including the aspect of sustainability. In the latter domain human freedom and human rights are two such suggested dimensions as propagated by (Sen, 2001) and Dasgupta (2001). It is rational to expect that these areas and alike would be addressed in a volume like the present one (published in 2010). This expectation has been belied. But still there is no hesitation to recommend that first four chapters, if not any one else, would make the book an essential reference to all serious researchers in the area of human development.

Dasgupta Partha (2001): Human Well-being and the Natural Environment, OUP, N.Delhi

National Council of Applied Economic Research (1999): India Human Development Report; North-East India, OUP, N.Delhi

Sen Amartya (2001): Development and Freedom, OUP, N.Delhi

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